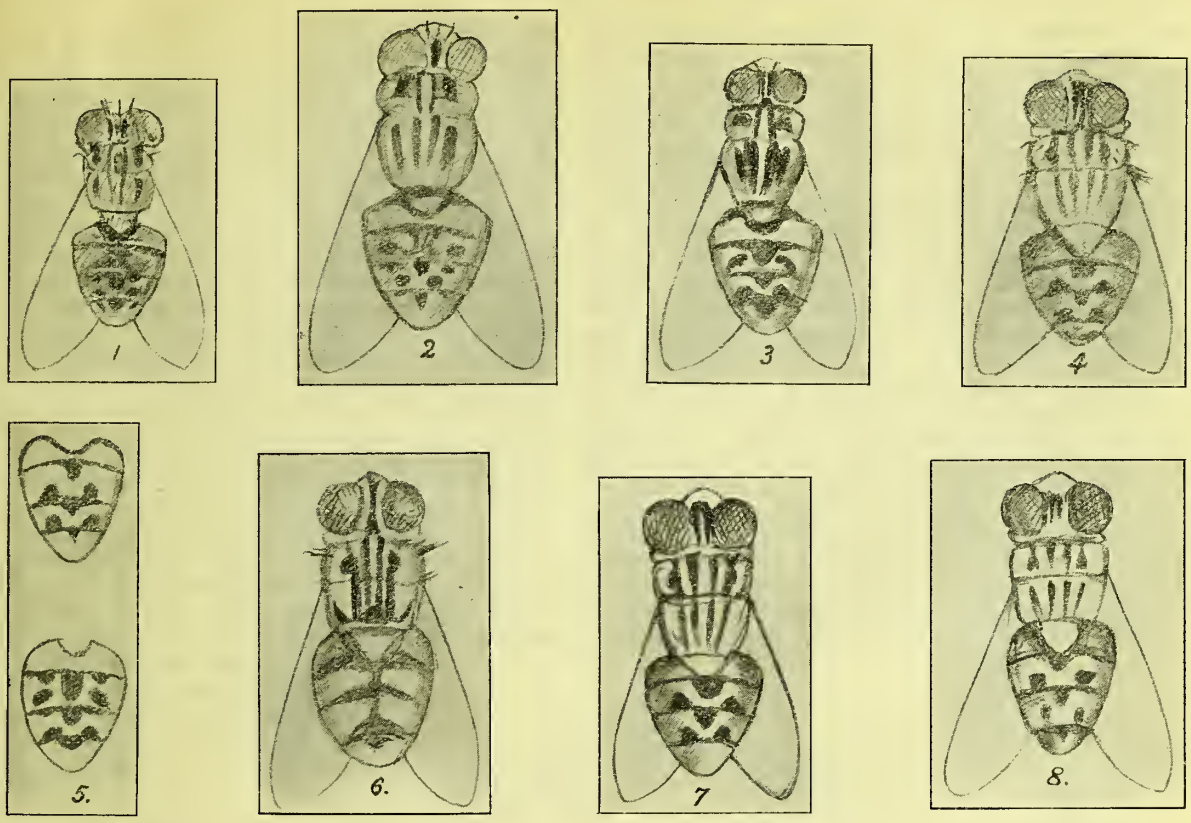
THE ANATOMY OF THE BITING FLIES OF THE GENUS *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Retired.)

In the fifteenth report of the Liverpool School of Tropical Medicine, p. 14, published last year, the writer made some note of a trypanosomiasis of horses existing in Kumassi which appeared to be conveyed by a species of *Stomoxys*. Bodies which he regarded as an evolutionary stage of the parasite were found in the fluid taken from the stomach of a fresh insect dissected on the spot, but, unfortunately, the visit was



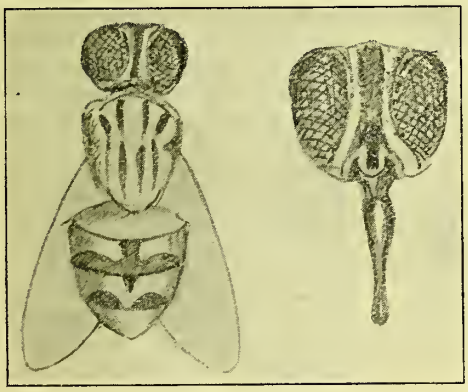


Fig. 9.

Fig. 1.—*Stomoxys calcitrans* from Malta.

Fig. 2.—Same species from the New Forest.

Fig. 3.—"Blotched" form *Stomoxys* from Kumassi.

Fig. 4.—*Stomoxys occidentalis* from United State.

Fig. 5.—*Stomoxys* sps. from Algiers and Jamaica, much resembling the blotched form.

Fig. 6.—"Banded" form *Stomoxys* from Kumassi.

Fig. 7.—*Stomoxys* sp. from Indian Terai.

Fig. 8.—*Stomoxys sugillatrix* from South America.

Fig. 9.—*Stomoxys* sp. from Gambia, possibly *St. sitiens*, Rondani, from Abyssinia.

so hurried, the object of our visit to the "Coast" being mainly to examine into the actualities and possibilities of anti-malarial sanitation, that little more could be done than to carefully prepare a number of the flies for subsequent microscopical examination.

The examination of this material has since been undertaken, but though bodies have been met with which it seemed might be referable to protozoal parasites, Prof. Minchin, to whom they have been submitted, does not consider that they represent stages of a trypanosome.

At an early stage of the work it became evident that some comparison with flies known to be free from disease of the sort was imperative, and it was necessary to turn aside and examine English specimens of the same genus which are, fortunately, fairly easily obtainable; and some comparison with the flies of the genus *Glossina* was clearly desirable. This piece of work took up much time, and as has been seen, remains the only solid result for the labour involved.

Meanwhile a report by Prof. Minchin on the anatomy of the tsetse-fly has appeared in the *Proceedings of the Royal Society*, V. B. 76, 1905, p. 531, and a similar paper on that of *Stomoxys*, by Lieut. F. Tulloch, R.A.M.C., is in the press. The present communication, therefore, is devoted mainly to such points as are not covered in these communications, which will be quoted whenever possible, though some repeti-

tion may be unavoidable. My thanks are greatly due to Prof. Minchin for giving me advance proofs of Lieut. Tulloch's valuable paper. It may be noted that the word "stomach" in Prof. Minchin's paper should, he wishes to state, read proventriculus. As a matter of fact, it is very difficult to avoid ambiguity in the use of terms such as "stomach." Strictly speaking, the diptera have no "stomach" in the sense of a localised dilatation of the upper part of the mid-gut.

In the mosquitoes, what is called the "stomach" is the entire mid-gut, with the exception of the narrow anterior part contained in the thorax and forepart of the abdomen. In the Muscidæ, including the species under consideration, there is no stomach in the sense of a localised dilatation, but the anterior part of the mid-gut forms a long tube of sausage form, and has distinguishable characteristics from the parts behind. Lowne, in his classical work on the blow-fly, calls this the "chyle stomach," and the continuation of the tube as far as the point of entry of the Malpighian tubes the "proximal intestine," while, between this and the commencement of the rectal valve is a short piece of intestine which he speaks of as the "metenteron," distal intestine, or hind gut. What Professor Minchin speaks of as the "sucking stomach" Lowne usually calls the crop, and as it is difficult to ascribe any aspiratory function to this organ the former term is to be preferred, although it is placed in the abdomen, and not in the neck, like the crop of a bird.

These explanations are necessary, as frequent references to Professor Minchin's account of the anatomy of *Glossina* are necessary to avoid needless repetition of work already performed, but Lowne's terminology will be adopted in the account that follows.

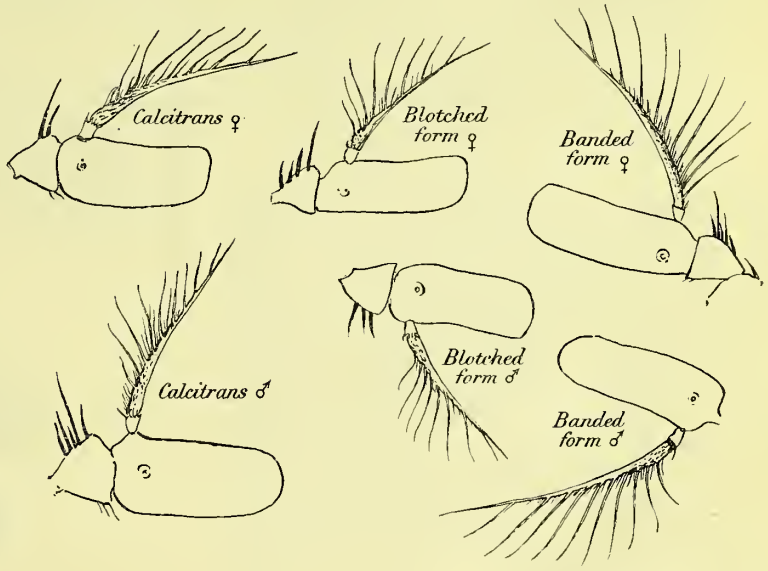
The genus *Stomoxys* includes a small group of biting flies, which resemble each other so closely that their distinction is an extremely difficult matter. It appears to be truly cosmopolitan, species or races being reported from all parts of the world. The type species may be taken as *Stomoxys calcitrans*, which is common in all parts of England, especially where horses are allowed to run wild, as in the New Forest, where it is locally known as the "forest horse-fly," and the pony owners have an erroneous idea that it is peculiar to the neighbourhood. It has been found also in Malta, North Africa, and Jamaica, and flies from the Indian Terai closely resemble it, as also does *St. enos* from New Zealand, and *St. vernon* from British Columbia. *St. occidentalis* from the United States, and *St. suggillatrix* from South America, are also closely similar.

Curiously enough the flies brought by me from Kumassi, and collected together from a swarm that was tormenting the animals in the horse lines there, included two fairly distinguishable forms.

As Mr. Austen, of the British Museum, is shortly undertaking an examination of this genus, and careful drawings are being prepared for the purpose, it was decided not to attempt to name these forms, but to speak of them for the present as the "blotched," and "banded" forms respectively. The former closely resembles *C. calcitrans*, while the latter is much like some specimens in the Museum derived from the island of Mauritius.

The accompanying rough figures give some idea of the markings of these various forms and of the closeness of their resemblance to each other, but does not pretend to close accuracy or proportional size, as any attempt to do so is clearly superfluous in view of the fact that the task is at present in the skilful hands of Signor Terzi.

I am inclined to think, however, that a means of distinction is to be found in the flagellum of the antenna or arista, as it is usually called by dipterologists. This structure is provided with a discrete fringe of long hairs, and I find that the number of these varies in the different forms, as well as sometimes in the sexes of the same species. Besides the long hairs, there are a number of shorter ones which may be spoken of as accessory hairs, and in *Stomoxys calcitrans* these are much longer than in either the "blotched" or "banded" forms.



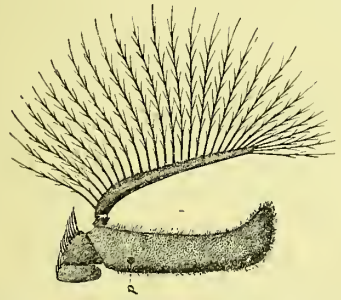
The above figures will illustrate my meaning better than much description.

The long main hairs spring more from the dorsal side of the arista, as it is usually carried by the insect, and so project almost directly upwards, while the accessory hairs are arranged along its inner side, and project inwards and upwards. In specimens mounted in balsam both ranks are forced more or less into the same plane, and are so represented in the figures. Besides the two principal ranks the proximal half or more of the arista is closely clothed with hairs, which in some cases are as long as those I have termed the accessory hairs, but neither these nor the extremely close dress of fine hairs that cover the antenna proper are represented in the camera

lucida drawings. The principal hairs are, it will be noted, simple.

A glance at the drawings shows that the three forms can be quite easily distinguished, and moreover, that the "banded" Kumassi *Stomoxys* resembles the English *St. calcitrans* more than the "blotched" form, which resembles the latter more closely in colouration. Both sexes in the "banded" insect have ten principal hairs, whereas in the blotched one there are but eight in each sex, and the entire arista is shorter proportionally to the last joint of the antenna. In both sexes on each of these forms the accessory hairs are quite short. *Stomoxys calcitrans* has seven principal hairs in the ♀ and nine in the ♂, and may be further distinguished from the banded form by the comparative smallness of the fork formed between the termination of the arista and the most distal principal hair. The accessory hairs are also very much longer than in either of the other forms, especially in the male, a further peculiarity of which is that the next but longest principal hair is provided with a small branch about half-way in its length. As far as observed these characters appear to be constant, but the series examined is not numerous enough to speak with certainty on this point. The remaining forms mentioned have not been examined, as they were British Museum specimens, and it is hardly possible to produce an accurate drawing for comparison without mutilating the specimen so as to be able to mount the antenna in balsam.

The antenna of *Glossina*, a drawing of which is reproduced from Mr. Austen's monograph, as will be seen, differs entirely in having compound principal hairs. Among the flies recently sent to the Museum is a *Stomoxys* from the Gambia, easily distinguishable by the brilliant white marking of the frons, and which answers fairly to the description of *St. sitiens* from Abyssinia.

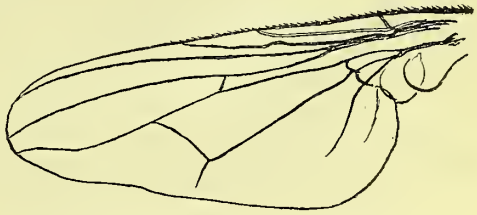


Rondani's description is, however, too brief to admit of certain identification without comparison with his types. Besides this there is a form from Somaliland which much resembles my "banded form," in marking, and as far as can be made out in the armature of the arista, but is easily distinguished by the pinkish colour of the lighter markings on the frons. On the whole, however, it seems improbable that more than half-a-dozen forms will require to be distinguished.

The genus *Stomoxys* was founded in 1762 by Geoffroy "L'Hist. abregeé des Insectes," ii., p. 538), with the following definition: "*Antennæ patellatæ seta laterali pilosa, os rostro sululato simplici acuto, ocelli tres.*" He notes further its close superficial resemblance to the common fly, but remarks that "its more widely separated wings and its shorter abdomen give it a look that make it easily recognisable to close observation. In France it is commonest in autumn, and he points out that this probably is the origin of the old French saying, "les mouches d'automne pignoient." His figure is unmistakable.

A more modern definition is to be found in Schiner's "Fauna Austriaca," i., p. 577, but is no better suited to the requirements of modern classification, as it is so planned as to include *Hæmatobia*, which differs from *Stomoxys* in the easily recognisable character of having the palpi nearly as long as the proboscis, whereas in *Stomoxys* they are of quite insignificant dimensions.

The venation of the wing presents nothing very characteristic, and is so closely similar in the various forms that it is unlikely to be of much service for the distinction of species. Moreover, owing to the wing being far from flat it is difficult to so mount specimens as to obtain strictly comparable outlines for comparison.



Stomoxys, banded form, ♂. Venation of wing.

Just as in the case of the common house-fly, the tropical forms on *Stomoxys* are considerably smaller than the English insect. The two sexes resemble each other so closely that it is difficult without close examination to distinguish them from each other, especially as both males and females are equally bloodthirsty, and a gorged male often distends its abdomen to such an extent as to look much like a gravid female. The most prominent point of difference is that the space between the eyes is much wider in the females. Examined casually the abdomen differs but little in the two sexes, but a closer examination reveals the point that while that of the female ends in a papilla-like ovipositor, the hypopygium of the male is tucked under him in much the same way as that of the female crab. On closer examination the male genital apparatus proves to be of a very complicated character, and this, too, may prove of service in classification.

(*To be continued.*)

surface is almost nude. It is connected with the lower part of the face of the insect by means of a soft membranous piece consisting of the combined bases of the labium and maxillæ, and bears on its dorsal aspect, close to the face, the short, single-jointed

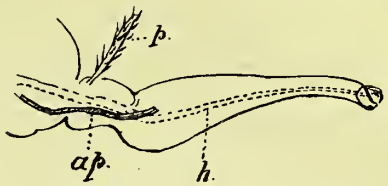


Fig. 13.—Profile outline of proboscis of Stomoxys. *p*, palp; *h*, dotted line indicating position of hypopharynx and labrum; *ap*, apodeme or sclerite which articulates with the fulcrum and serves as a jointed point of support to the proboscis. Semi-diagrammatic.

maxillary palps. This soft basal portion is about a quarter the length of the main radish-shaped part of the organ, and its length and flexibility permits of ample motion in flexion and extension, and to some extent also of protrusion and retraction, the necessary stability of the radish-like part being afforded by a pair of slender chitinous rods, the furca, which articulate with the fulcra, at their proximal ends, and distally, with the bases of the lancets.

Through the axis of this flexible basal portion runs a chitinous tube, continuous behind with the buccal cavity, and in front with the grove of the lancet, which in this insect consists of the labrum only.

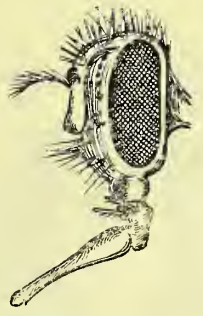


Fig. 14.—Head of Stomoxys in profile.

The above rough sketch gives a fair idea of the organ in the position it is usually carried by the insect, but the basal portion is often flexed backwards almost against the base of the head, and on the other hand the trunk portion can be extended so as to almost touch the antennæ.

A glance at the profile outline below shows that it would be difficult to plan a sheath for the lancets less suited to act for itself as a piercing organ. The labella form an ostentatiously blunt extremity to the organ, and are furnished with delicate hairs and elaborate tactile organs, while the abrupt thickening of the basal four-fifths makes it clearly impossible that it should ever act as a rapid piercing organ, if, indeed, it could be in any way possible to employ it as such. No boring instrument that I know of, devised either by Nature or by man, has this form, and when, for want of a better

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(*Continued from p.* 102.)

The distinguishing generic characteristic of *Stomoxys* is, however, the form of the proboscis, which, though presenting a strong general resemblance to that of *Glossina*, differs so markedly in outline that it can be recognised at a glance.

The organ is shaped like a radish, with a bold curve, convex on the dorsal aspect, and is slightly swollen at the tip. With the exception of the ends of the labella, which are clothed with long thin hairs, the

tool, one is driven to try to use a piece of steel of this shape as an awl, one at once finds how utterly unsuited it is for the purpose. Let any one who doubts this try to sew leather or canvas with an ordinary packer's needle, which is efficient for the workman's purpose, merely because the sacking he works with is of so open a texture as to be almost a net, and yet the tool is better shaped than the proboscis of Stomoxys, as would soon be seen if one tried to sew sacking with a needle so shapen. Those who have been driven by emergency to use an ordinary sewing needle for suturing the human skin will fully appreciate the force of these arguments, though a sewing needle has a far more delicate point than the proboscis of this fly, and the needle, for strict comparison, should have its point broken off. The labrum, on the other hand, which has a point fashioned exactly like that of the ordinary and very business-like hypodermic needle, is as admirably adapted for piercing as the labium is the reverse, as may be seen from the accompanying camera lucida outline of the two organs drawn from a fly in which the labrum happened to lie separate from the sheath.

Fig. 15.—Outline of head of Stomoxys seen from side and rather from above.

Let us now examine more closely the structure of this organ. The proboscis in the ordinary resting position of the parts as seen in the living insect shows nothing but the labium, or lower lip, the function of which, as already noted in a preliminary communication to this Journal, is, I maintain, simply that of a sheath to the true piercing apparatus. The main part of this consists of a radish-shaped mass, already sufficiently described, and this supports a pair of small lobular organs, the labella, which, apart from the relative proportions of the parts, resemble the larger expansions which are so familiar to us in the favourite popular microscopic object usually labelled as the "tongue of the blow-fly." These lobes are obliquely articulated with the slightly constricted trunk of the proboscis, and in the fresh state can be made to separate by pressing the proboscis down on an object slip or other resisting surface. When in this position, it is needless to say that the labella make the labium even more obviously impossible as a piercing organ than when folded together in their ordinary posture of rest.

If we now proceed to dissect the separated proboscis it will be found that it is not difficult to separate the black outer coating, except from the labella, and that when this is done, we are left with a delicate plate of chitin (sclerite) which forms a sort of median antero-posterior septum, and on either side a great mass of muscle which takes origin from the chitinous furca, which just reach up to the beginning of the thickest part or bulb of the proboscis, and is inserted into the anterior part of the median scleriti by tendinous fibres of varying length. Hence if the proboscis be detached by cutting it off immediately behind the bulb the muscular mass separates from the containing integuments with the greatest facility owing to its being left quite without hinder attachments. Behind, however, there is nothing to prevent the median sclerite from sliding back between the furca.

If we now examine a specimen from which the soft parts have been removed with caustic soda, it will be found that the outer skin, in spite of its blackness and deceptively solid appearance, is thin and flexible, and is, moreover, wrinkled transversely at fairly regular intervals. These transverse folds run almost transversely round the basal part of the proboscis, but towards its extremity, run rather forward on the ventral side to meet together in broad V's. These transverse lines give to the entire organ a close resemblance to a leech, which is much heightened by the remarkable similarity of general contour, and it is impossible to interpret them in any other way than that they are the outcome of habitual infolding which, exactly as in the leech, permits of the whole structure being shortened.

If we now examine a transverse section of the organ it will be found that it consists of a solid conical mass, the anterior side of which is grooved with a narrow rabbet, the depth of which, however, is not more than

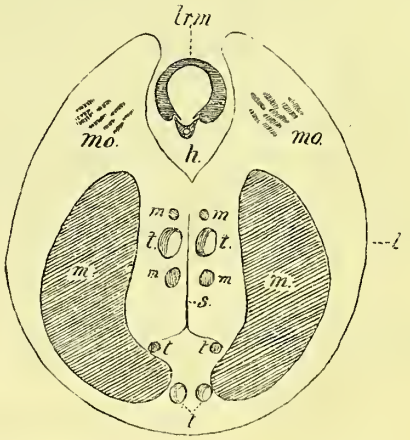


Fig. 16.—Transverse section of proboscis of Stomoxys at about mid-length. *h*, Hypopharynx; *l*, labium; *lrm*, labrum; *m*, muscle; *s*, median sclerite; *t*, tracheæ. Camera lucida, semi-diagrammatic.

one-third of the thickness of the cone. Dividing it into two lateral halves is the median sclerite which is stouter on its ventral than on its dorsal edge, and lies immediately under the skin of the groove dorsally, while the stout ventral margin has attached to it two delicate septa which run off on either side to the great muscular masses and serve to separate the ventral median from the two great lateral air sacs. The entire width of this sclerite is little more than one-third that of the diameter of the cone, and as its thin dorsal edge is close under the rabbet, while the

ventral edge is almost a third of the diameter of the organ from the ventral integuments and separated from them by the great ventral median air chamber. Lying on either side of the axis of the cone are two great tracheæ which break up in front into branches which appear to open into the two antero-lateral air sacs. Behind and in front of each trachea are extremely slender muscles, the hinder rather the thicker, the function of which I am unable to make out, but conjecture that they are in some way concerned in keeping the crease between the labellæ from outfolding under the air pressure of the pneumatic sacs. In the dorsal portion of the section within the alæ forming the sides of the rabbet are seen a number of obliquely divided muscular films. There are two sets of these which serve respectively to separate and to bring together the labellæ; so with the difference that the prehensile lobes of the labella are lateral and symmetrical instead of different and antero-posterior, the whole proboscis presents some resemblance to that of an elephant, though the labella are, of course, relatively far larger. What purpose a pair of soft, hinged flaps can serve, when considered as the point of an awl, is difficult to understand, and it is for those who assert that the function of this elaborate mechanism is simply to pierce the skin, as a bradawl is driven into a plank, to show what may be the object of all this complication, and what may be the function of the various muscles and other parts concerned.

A minute description of even the external anatomy of the labella would alone occupy a lengthy paper, for

Fig. 17.—Labella of Stomoxys seen from ventral side to show the rank of large teeth. To avoid confusion, the complicated ranks of plates behind them are not represented, and only a couple on each side of the pellate hairs of which about a score are scattered over the end and sides of each labellum. On the left side is shown the rank of grapnel hooks, and on the right the position of these is only indicated by small circles so as to show better the double rank of long bristles.

it is provided with so great a variety of hairs, plates and sense organs that it is extremely difficult to condense an adequate account of it into moderate limits. Internally it is simple enough, the entire space, with the exception of some muscular fibres which are inserted into the bases of some of the larger plates or teeth, being occupied by a large air sac continuous with those of the main trunk of the proboscis, so that the point of this reputed borer is formed by an air cushion.

Viewed ventrally, with the labella slightly separated, it will be seen that the most prominent structures are a row of strong leaf-shaped blades or teeth which project inwards and forwards towards each other, so that in the natural position of rest they are folded together and cannot engage the skin of the blood-yielding animal except when the labella are spread out to full expansion. They are four or five in number on either side (I am not sure of the hindmost, which may belong to another rank of plates), and are the only at all powerful teeth that are to be found, though it is difficult to see how they can effect a sufficiently large wound to admit of the rest of the structure following them. On the other hand, it is easy to see that they can form efficient holdfasts if the labella are pinched together after they have entered the skin when they have been applied to it with labella expanded.

Outside these is a row of very obvious grapnel hooks. These are arranged in pairs, with the exception of the hindmost, which is single, each pair being opposite an interspace between the leaf-shaped blades. Finally, outermost of all, is a double row of rather long, stiff bristles. Quite behind, on either side of the fold between the labella, is a large papilla. The whole of the tips and outsides of the distal third of the labella is sprinkled with very peculiar pellate hairs of extremely delicate structure. There are a score or more of these on each, but a couple only have been drawn to show their relative size, as to do more would needlessly confuse the figure. Their function is probably sensory, and it is conceivable that they may be gustatory organs, as the membrane of the little shield at the end is excessively delicate. From their form and delicacy it is obvious that they would never outlast the labella being once forced into the skin.

To obtain an idea of the complex system of plates and structures behind these it is necessary to make a dissection so as to clear away one

Fig. 18.—Side view of the end of proboscis of Stomoxys, the integument and muscles being removed to show the median sclerite.

labellum, and in doing so, by clearing away the integuments of the supporting trunk, it is easy to establish that the true support of the labella is the median sclerite (*S*) already described. When this

has been done it will be seen that inside the large leaf-shaped blades are two or more ranks of extremely delicate lancet-shaped structures. Next to these a row of tufts of short dense bristles, and inmost a rank of stout bristles. On the most anterior part is a dense mass of minute hooks. Personally, I regard these curious structures as having the function of sufficiently abrading the surface to admit of the character being tested by taste, but there is nothing whatever in their size and form, or in the fact of their presence, to suggest that they are in any way concerned in any deep piercing of the skin of the animal that yields blood to the fly, for "teeth" of this sort are to be found on the labella of all Muscidæ, such as the common house-fly, and which certainly are quite incapable of doing anything more serious than of licking the surfaces of what they feed upon.

I cannot give the exact reference, but if any one cares to look up the files of *Science Gossip* of the early eighties, he will find a series of very interesting papers on these teeth of flies, which are illustrated by some very beautiful coloured plates, and will find that many of the most harmless flies have much more formidable teeth than those with which *Stomoxys* is provided.

(*To be continued.*)

people. The mothers apply a black dye or pigment round the eyelids of their infants after the child is old enough to be taken out. The black substance is said to be a natural earth dug from some of the hills, but I believe any black pigment will serve the purpose. The explanation of this practice varies; some say that it is only done for looks' sake, some that it is to protect the delicate young eyes from the strong light and the glare of the dry ground, while others admit that it is done to annul the intentions of any evil-minded person who might be envious of her neighbour's pretty child and overlook it for its harm. The first of these reasons is hardly sufficient, for their dark skin throws the white of the eye into sufficient relief without the artificial aid required for that purpose by the belles of the West. The second explanation, that it protects the eyes from the glare, has something to be said for it, for I have noticed in white dogs when one eye lies in the midst of a black or brown patch, and the other is surrounded altogether by a white ground, that the former eye is strong, and free from inflammation, while the latter is very often the seat of a chronic conjunctivitis. The greater amount of pigment in the skin of the dark patch seems to diminish the irritating effects of the light and glare. However, as the black eyes of the natives rarely suffer from this cause, the third explanation would seem, perhaps, to be the right one, namely, that it protects the child against the "evil eye."

Another example may be given. When riding about one often sees near a busti, or native croft, as it may be called, a clay cooking-pot with a few white lines and circles painted over its bottom, hanging mouth downwards high up on the end of a bamboo pole; this too, I believe, is intended as a protection against the "evil eye." The design on the upturned pot, which seems always to be an old one with a black bottom, is two white lines crossing one another, with a small white circle in each of the four triangles thus formed, a rough imitation, perhaps, of a human face with four eyes, and intended to attract the glance of the "evil eye," thereby diverting its malign influence from the house and its inmates: a spell, doubtless, not less potent than ours of hanging up a horse-shoe by the door-lintel.

A possible explanation of the origin of this practice has occurred to me. When the rice harvest has been gathered in the straw is built up in round stacks which have a pole running up the centre to keep them upright. Since these stacks are never thatched the heavy rains would get in at the top around the pole, and rot the straw, and to prevent this a small clay cooking-pot is put over the top of the pole, so that the rain is diverted all round. At the end of the year, when the straw has been used up, the bare pole is left standing with its hat at the top like a very tall mushroom with a very small head, and it thus forms a rather striking object, and in course of time it would probably occur to someone looking about for a prominent point of advantage whereon to inscribe his anti-charm that here was the very thing, so that by and bye the cymbal would be set up altogether independent of its original purpose.

The Scapegoat.—The old Hebrew custom of laying the sins of the people upon a goat and turning it adrift into the desert still exists to some extent among the Hindoos, who resort to this device in order to rid their family of illness. Since a goat is rather too expensive for a poor man's purse he utilises a chicken instead. The "bhoot" which is supposed to be the cause of the person's illness is exorcised into the hapless chicken, a red mark is then put on its forehead, and it is taken well out into the jungle and allowed to escape. The disease is expected to go with it, and its former owner feels no qualms of conscience to think that some innocent mortal happening across the "scapegoat" may become a new victim. But the danger therefrom cannot be very great, for I know a sahib who once stumbled over one of these escaped chickens, and, taking pity on it, put it in his pocket and brought it home, unwitting of the risk he was running, and he is yet alive and well. Another ingenious if equally unkind device to rid one's self of an illness and foist it on another is to set down a pair of wooden shoes belonging to the patient hidden from sight at a point where two paths meet. Strings are fixed to the shoes and to wooden supports at the sides of the road, so that the first person coming along steps into the trap, the threads break, and the patient is cured of his disease at the expense of the newcomer. It is chiefly during epidemics and in long illnesses that resist medical treatment that belief in demoniacal possession gains the upper hand of the people, and compels them to resort to charms and incantations; at other times they are quite ready to seek the help and carry out the methods of modern medical science.

THE ANATOMY OF THE BITING FLIES OF THE GENERA *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Rtd.).

(*Continued from p.* 156.)

Of the pseudo-tracheæ of the "tongue" of the commoner flies I have as yet discovered no trace, but behind the leaf-shaped blades are two other rows of five strongly chitinised teeth of nearly as large size as those first described. Of these the one next to them has teeth with ends like that of a cheese-cutter, while the innermost has a point curiously serrated on one side, and a number of short, stout, intensely black-blue bristles may be also added, but a complete description of this wonderful structure would exceed all reasonable limits. To conclude the description of the labium, it will thus be seen that, though somewhat stiffened by its median sclerite, it is quite without any basal support, as the median sclerite tapers away to nothing at the base, and the external integument, though deceptively dense to external appearance, is really soft and flexible, and specially creased to admit of its being shortened in the same way as an accordion.

If we now turn to the upper lip or labrum, we find a structure formed exactly on the model of a hypodermic needle, and in every way as admirably adapted for piercing as the labium is obviously impossible for such a function. It differs from the familiar surgical

instrument only in the detail that the tube is incomplete, a narrow slit running along its entire ventral surface to the point, where it expands, so as to make the organ end in a point, like that of a pen. It forms, however, fully three-fourths of a complete tube, and the remaining fourth, as will be seen by reference to fig. 16, is completed by the dorsal surface of the hypopharynx. It must be remembered that all members of the fly family are provided with a similar apparatus, the difference being merely one of relative length.

Though in reality continuous with the delicate membrane that at first forms the upper wall of the tubular buccal cavity, the dense chitin of which it is composed ends abruptly at a line a little before the base of the labium, and its two corners articulate with a pair of sclerites, named by Lowne the apodemes of the labrum, which in their turn articulate with two cornua projecting forwards from the chitinous skeleton of the cephalo-pharynx, called the fulcra by the same writer. These apodemes are rod-like structures, which closely resemble the human clavicle in form; and the fulcrum is a hollow frame of chitin of rather curious form. Behind it may be taken as continuous

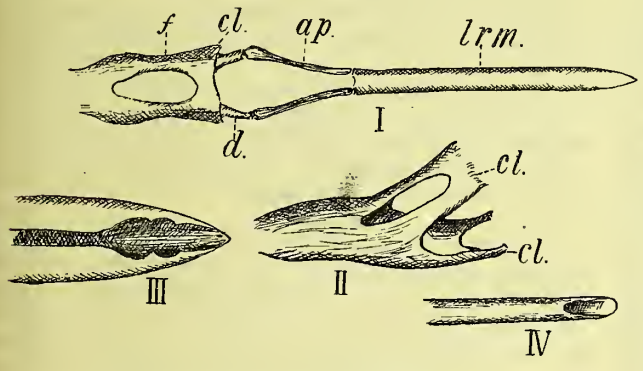


Fig. 19.—I. Semi-diagram showing the chitinous skeleton of the labrum, or upper lip: *ap*, apodeme of the labrum; *cl*, chitinous plate uniting epistome with the clypeus; *d*, distal cornua of fulcrum; *f*, fulcrum; *lrm*, labrum. II. The fulcrum drawn in perspective. III. Point of labrum; and IV., end of hypopharynx at the same higher magnification.

with the pharynx, but in front the sides are open, while the dorsal and ventral aspects are prolonged as two plates, the upper one of which turns upwards to fuse with the clypeus, and so affords an immovable connection with the chitinous exoskeleton for the front of the head. This plate is pierced by a large foramen which gives passage to the nerves and tracheæ of the trunk, and also for an air chamber continuous in front with those of the labium and behind with those of the head and of the body generally. The lower plate, on the other hand, is shaped much like the half of a butcher's tray, the handles of the tray being represented by the two cornua which again articulate with the proximal ends of the apodemes. The labrum is therefore connected with the skeleton of the head by the intervention of two joints, movable only in flexion and extension, and each capable of being moved or fixed by appropriate muscles. The point of the labrum is bevelled, and the edges of the resulting pen-like structure are each armed with two keen but not very trenchant teeth of such a form as to equally facilitate rapid withdrawal and insertion. When in function the slit in the ventral aspect of the tube is closed by the apposition of another structure, the hypopharynx. This springs from the floor of the mouth, level with the base of the labrum, and is a prolongation of the salivary duct. It consists of a delicate but fairly stiff tube, the dorsal side of which is produced laterally to form two alæ, which curve backwards in such a way as to form a fairly deep groove on its dorsal side. Seen in section (fig. 16, *h*), it is seen that the tube is comparatively small in proportion to the thickness of the walls, but it must be endowed with considerable elasticity, as was shown by a curious accidental experiment.

I had placed an entire insect in water (from spirit), with the view of dissecting the proboscis, and had spread apart its three components, when, under my eyes, the hypopharynx began to swell and lengthen, till it protruded a long way beyond the labella, and at last it snapped in the middle, after which the pieces rapidly resumed their original size. The orifice of its tube, I conclude, was in some way obstructed, and osmosis had done the rest. Sections of the entire proboscis show that the alæ fit into a curious slot in the edges of the labrum and so convert it into a complete tube through which the blood is drawn into the œsophagus.

The arrangement recalls in many ways that whereby the outer case of a cycle tyre secures itself to the rim of the wheel, which in this case is represented by the hypopharynx, but is designed to make the resulting tube withstand not positive, but negative pressure.

As already indicated, I do not believe that in *Stomoxys* the labium has any share in piercing the skin, but that it acts as a protective sheath to the more delicate lancet, and supplies the muscular force whereby the latter is driven into the skin. This, the writer believes, is effected in the following manner: By means of the various hooks and blades of the labella it attaches itself to the skin of the animal to be operated on, and then by a contraction of its powerful longitudinal muscles forcibly shortens itself, so that the labrum is made to protrude and, guided by the labella, is thrust into the skin. With a little trouble it is possible to imitate this in a fresh fly to some extent by handling the labium with the needles so as to make it lengthen and shorten. As there is no bending out of the way of the labium, such as occurs in the mosquito, it appears to the observer exactly as if the labium itself had entered the skin; the illusion being something on the principle of the stage dagger.

It must be remembered that the parts are none too large, and that any one attempting to watch the process cannot put his head too near, for fear of disturbing the fly, added to which, when animals are bitten, the fur further interferes with the possibility of seeing exactly how the operation is performed. To watch the process to any purpose would require the use of a powerful hand lens, and this is, of course, out of the question.

From the comparative point of view, the anatomy of the proboscis of *Glossina* closely resembles that of *Stomoxys*, but differs remarkedly in many details. At

their bases, the resemblance between the two proboscs is fairly complete, and the foregoing description of the chitinous skeleton of the mouth-parts might here stand almost as well for those of *Glossina*, but here the resemblance ends. A very cursory examination shows that the visible parts of the proboscis

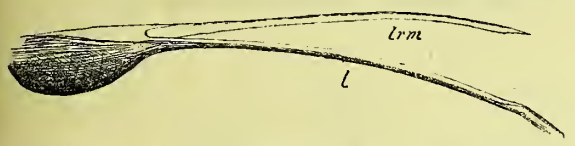


FIG. 20.—Proboscis of *Glossina palpalis*. *l*, Labium; *lrm*, labrum.

(labium) consist of two distinct parts, a large basal bulb, as thick or thicker than the base of the labium of *Stomoxys*, and a long, extremely slender rod ending in a blunt end, slightly bent backwards, so as to form an instrument exactly like a French urethral bougie. This slender part is densely chitinised and hence very stiff, but the bulb has a thin flexible integument like that of the other species. Moreover, the pair of large muscles which largely fill up the bulb, instead of remaining muscular nearly to the end of the proboscis, terminate in two delicate tendons which run through the entire slender portion to be inserted into the base of the labella.

The form of the hypopharynx and its relations with the labrum are entirely different from any other fly I have examined, and conclusively show the correctness of the general opinion that the entire slender part of the proboscis is introduced into the wound in the skin.

In *Stomoxys* and the other flies as yet examined by me, the apposition of the labrum and hypopharynx forms a tube through which the food of the insect is conducted to the œsophagus, but between these two parts in *Glossina* there is no tube, because the apposed parts are moulded to exactly fit each other.

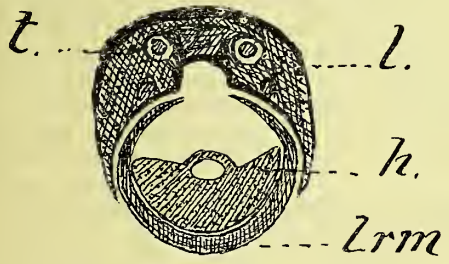


FIG. 21.—Tranverse section of the proboscis of *Glossina palpalis* at almost mid-length. *h*, Hypopharynx; *l*, labium; *lrm*, labrum; *t*, tendons of the contractor muscle of the bulb enclosed in tubular chitinous canals in the substance of the labium. *Note.*—The ventral side of this figure is uppermost.

As will be seen from the figure, the hypopharynx is a solid rod of semilunar section, with a rib running down its flat ventral face within which is the salivary canal. The convex dorsal side fits closely against the labrum, which is wrapped round it, the edges of the latter extending beyond its own, and inverted so as to form quite five-sixths of a complete tube. In somewhat similar manner the labium is wrapped round the labrum, the edges of the former overlapping those of the latter for quite a quarter of the circumference of the tube formed by their apposition. The slot on the dorsal surface of the labium therefore forms rather more than half a circle, and opposite the slit between the edges of the labrum runs a minor groove of the same width. Both walls of the labium are very thick and densely chitinised, especially in the middle line, and it it further strengthened by infoldings of chitin which support the sheaths of the long tendons of the contractors of the bulb.

The thickness of the slender part of the proboscis is less than 0·04 mm., and its length 1·4 mm.; that of the bulb 0·57 mm., and that of the part of the labium that projects beyond the labrum in the position of rest 0·17 mm.

An examination of the above drawing (fig. 20), however, shows at once that the labium, with its blunt, bougie-like end, is quite unsuited for piercing the skin, while the labrum is eminently adapted for doing so. A shortening of the length of the bulb by even a third of its length, through the action of the powerful contractor muscles, would suffice to bring the cutting point of the labrum beyond the blunt end of the labium; and assuming the latter to be fixed to the skin by means of the jagged teeth of the labella, would enable the former to make a wound into which the labium could be introduced like a probe. Once introduced, a sawing alternate action of protrusion and retraction of the labrum would enable the entire apparatus to penetrate to its full depth with comparative rapidity, as the mouth of the wound would be at the same time enlarged by the saw-like edges with which, it will be noticed, the sides of the labium are provided. The labella are smaller and certainly much more rigid than in *Stomoxys*. Judging from spirit specimens, one would say that they were anchylosed to the trunk of the labium, but probably in fresh specimens they can be separated to a moderate extent. Hausen's description and figure of the labella in Mr. Austen's monograph of the tsetse-flies appears quite accurate, and as he suggests that some part at least of their armature is brought into action by the protrusion of the elastic membrane carrying them, it seems probable that he also regards the labella as capable of but little separation.

In the position of rest the united ends of the labella form a perfectly smooth, probe-like instrument, as the somewhat complicated armature of teeth and blades, with which they are provided, are entirely hidden between them. Even when protruded, however, it is difficult to imagine any method by which they could effect a wound large enough for the organ on which they are carried to follow them.

We will now proceed to some description of the organs contained within the head.

In the middle line, just above the roots of the antennæ, will be seen a minute foramen. This is the opening of a rather extensive cavity which extends backwards under the vertex nearly half-way to the occiput, and is nearly as wide as it is long. It has also a considerable depth, and from its floor two large median processes project into its interior, besides which there are sundry median and lateral diverticula. The whole cavity has a dense chitinous wall, and is closely beset with short conical hairs. The presence

of this cavity gives rise to appearances somewhat difficult to interpret in section, unless one is aware of its existence. This cavity is the inverted frontal sac, and in the pupa is everted to form a large bulla, by means of which the operculum of the pupa case is burst open to admit of the escape of the imago, but it does not appear to serve any function in the latter, so that its significance is entirely developmental.

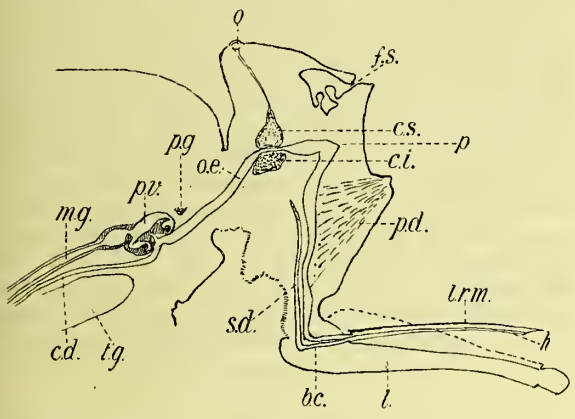


FIG. 22.—Vertical section of head of Stomoxys, semi-diagrammatic. *bc*, Buccal cavity; *cd*, duct of crop; *ci*, subœsophageal cerebral commissure; *cs*, supra-œsophageal cerebral commissure; *h*, hypopharynx; *l*, labium; *lrm*, labrum; *mg*, midgut; *o*, ocellus and its nerve; *oe*, œsophagus; *p*, pharynx; *pd*, dilatator muscle of pharynx; *pg*, proventricular ganglion; *pv*, proventriculus; *sd*, common salivary duct; *tg*, thoracic ganglion.

The buccal cavity is contained in the base of the proboscis, its anterior boundary, where the hypopharynx springs from the floor of the lower wall, being opposite the thickest part of the bulb. It is quite a narrow cavity, and is strengthened by transverse chitinous fibres, and it may be said to end and the pharynx to commence at the point where the soft flexible root of the proboscis begins. From this point the pharynx runs nearly vertically upwards in the axis of the head to a point opposite the middle of the large second antennal joint. Here it becomes the œsophagus and bends sharply backwards, in the longitudinal axis of the insect, to pierce the cerebral commissure, narrowing to an extreme tenuity, and then runs backwards and downwards through the neck to the under-surface of the proventriculus.

The pharynx is the true aspiratory organ by means of which the blood of the victim is sucked. It is of considerable size, being a quarter of a millimetre across at its widest part; but in the position of rest is a mere slit, the anterior and posterior surfaces being in contact. The slit is not, however, straight, but nearly semilunar, with the convexity backwards.

The concave ventral surface is formed of a dense plate of chitin, and is practically immovable, though it is steadied by a pair of lateral muscular bands. The anterior or dorsal surface, on the other hand, is soft and flexible, and inserted into it on either side are the powerful dilatator muscles which spring from the interior of the ridge which bounds the recess below of the hollow in which the antennæ lie.

When these muscles contract they must necessarily draw forward the flexible anterior wall of the pharynx; and as, from its density, the posterior wall cannot follow, it must needs convert the closed slit into an open cavity of oval section. In some respects the arrangement resembles that of the Culicidæ, but in them there is a localised elastic bulb which can be, like the pharynx of *Stomoxys*, actively dilated; but in that genus there can be no elastic contractility, and the return to the slit form of lumen must be through the agency of the pneumatic pressure of the great air sinuses with which the organ is surrounded.

In the above figure of a median sagittal section, the dilatator of the pharynx should, strictly speaking, not be represented, as there is a considerable interval in the middle line between the two planes of muscle, but to save an additional figure their direction is indicated by broken lines. The transverse section here

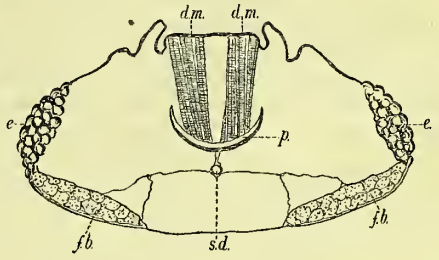


FIG. 23.—Horizontal section of head of Stomoxys. *dm*, Dilatator muscles of pharynx; *e*, lower edge of eyes; *fb*, fat body; *p*, cavity of pharynx; *sd*, salivary duct.

depicted will, however, serve sufficiently to indicate the true position of these muscles.

When piercing the transverse cerebral commissure, the œsophagus contracts to a lumen of no more than 0·015 mm.; and behind it the tube again dilates, but is compressed instead of depressed. The common salivary duct, from its origin at the base of the hypopharynx, follows the course of the buccal cavity and pharynx, at a little distance from it ventrally, and ends by dividing into the right and left ducts at a point about level with the apices of the antennæ. This is a good deal further back than as indicated by Hansen, and still more in contrast with the bifurcation in Glossina as stated by Prof. Minchin. Hansen (fig. 21, pl. 8, of Austen's monograph) also figures a large salivary reservoir.

It may be gathered from the context of his memorandum that he relied on his interpretation of the parts as seen in optical section through the integuments, and this probably accounts for the illusion, for the writer has no hesitation in stating that no such dilatation exists, as the duct has been followed in an unbroken series of sections from the hypopharynx to its bifurcation at the point indicated, and it nowhere exceeds 0·02 mm. in diameter. As far as can be made out, the spiral fibre which strengthens the duct in many diptera is wanting here. Shortly after entering the thorax the ducts cease to be chitinous and become glandular. In fig. 22 the size of the duct is intentionally exaggerated so as to make its position clearer.

The salivary ducts, after division, run together in

contact, close under the soft ventral integument of the head to the neck, and so do not follow the stomodeal canal, which is, however, accompanied in its passage through the cerebral commissure by a pair of tracheæ of about the same calibre as the salivary ducts, and by two nerve fibres.

Speaking generally, the anatomy of the head of *Glossina* appears to coincide closely with that of Stomoxys, but Prof. Minchin notes that the salivary ducts bifurcate further forwards. The most striking point about the brain of these and other flies is its large size, which must be relatively considerably larger than that of most of the lower vertebrates. There do not appear to be any details of special interest in the brain of either Stomoxys or Glossina, and as a large number of papers are easily available on the dipterous brain, any further description is quite superfluous. A very excellent account will be found in Lowne's work on the Blow-fly vol. ii., p. 453, and a shorter statement in Prof. Minchin's paper on Glossina in the *Proc. Roy. Soc.*, vol. B., 76, p. 532. Before quitting the head it may be well, however, to add a few words on the histology of the principal organs.

(*To be continued.*)

THE PURU OF THE MALAY PENINSULA.

By T. D. Gimlette, M.D.[1]

(*Continued from page* 153.)

The Varieties and Complications of Puru.

Malays distinguish the varieties of many of their diseases by a number of clinical names. For example, small-pox, which is common among them, has been given—under the name of "penyakit ketumbohan"—no less than eleven different descriptive names, according to the appearance of the pustules. Again, the average intelligent Malay will recognise at least seven different varieties of ringworm. Puru is divided in the same way into several varieties, the chief of which are: "Puru siput" or "puru kechar" ("siput" and "kechar," a shell); "puru mata kerbau" or "puru kerbau" ("mata," an eye; "kerbau," a buffalo); "puru sekam" or "puru dedak" (chaff or bran); "puru kretas" (paper); "puru kochi" (Cochin China sore); "puru tapak anjing" ("tapak," a footprint; "anjing," a dog); "puru pitis" (a small coin); also "puru parang" ("parang," a chopper) and "puru kenam." Puru of the foot is generally known as "bubol," but it is frequently referred to in Kelantan as "puru duriyan." "Bubol" has been somewhat fancifully divided into "bubol sarang" ("sarang," a nest); "bubol malai" (aigrette); "bubol susoh ayam" ("susoh," a spur; "ayam," a chicken), and "bubol bubok" (bubok," a wood maggot).

Of these Malay varieties, "puru siput" is characterised by its rupial-shaped sores, and is perhaps the most common. It is considered to be the most benign form. It is not painful, and the sores heal easily. An example of "puru siput" is shown in fig. 1.

"Puru mata kerbau" is common. The sores are very large, but heal readily. Kelantan Malays call this the real puru. It may be combined with "puru pitis."

"Puru sekan" is especially irritable with regard to itching.

"Puru kretas" is distinguished from other forms of puru by the general superficial character of the eruption. It is only skin deep, gyratory, very painful, and difficult to cure. It is the worst kind known and may cause death. It may be combined with "puru mata kerbau."

"Puru tapak anjing" is another bad kind of puru. It is very painful, and leaves large, though insignificant, scars, either similar to a dog's footprint or very irregular in shape. The sores are supposed to occur on the body, placed in the way a dog leaves marks after walking on the sands—here some and there some, and none in the middle.

Puru kochi has been mentioned under etiology. It is referred to in an old Malay dictionary as the venereal disease [16]. "Puru kochi" is said to be chronic. It is not considered fatal, although no native medicine will cure it. It is also called "puru glang besi" (glang, lit. a bracelet or anklet; besi, iron).

Puru kenam: in Kelantan "kenam" is said to occur when small children get lumps ("kenam") all over their body. It appears as circular red spots, and it is interesting to note that it is sometimes known as "puru Burma."

Puru parang is said to complicate other sores, and to be recognised by its deep ulceration. It occurs on the foot, and is said to attack old people.

There are various other unimportant so-called varieties.

Intercurrent diseases are generally the cause of death. A first attack of puru in old age is always serious. Young children may succumb, although rarely, to asthenia. Cellular abscesses may form. Scars are indefinite, but it is exceptional to find villagers who have not had puru early in life, and who cannot point in later life to some dark scar left by the disease. The old scar of "puru ibu" is well remembered by Malays, as are vaccination marks by Europeans. It resembles in appearance the scar of scalds or burns of the third or perhaps fourth degree, except that it is dark in colour. Scars are sometimes definitely depressed, and when on the face may cause contractions of the mouth known in Malay as "sipit mulut" ("sipit," puckered; "mulut," mouth). Permanent deformity of the limbs and ankylosis of joints may also be the result of puru. This disfigurement is very common, and is known as "birat" in Malay.

The Diagnosis of Puru.

Doubtless if the nature of puru were not well understood many cases of it might be classified as syphilis, because at first sight there seem to be many points of resemblance. Both rank among affections the study of which is mainly clinical; both are constitutional diseases with a period of incubation, efflorescence and decline; each is conveyed by direct inoculation, and followed in a slowly running course by the occurrence of remainders, and perhaps sequels with a tendency towards spontaneous cure. Puru is so well known to

[1] We have to apologise to Dr. Gimlette, inasmuch as we were in error announcing his valuable communication as a Craggs' Research prize essay.—Ed. J. T. M.

Case 3.—A man, aged 38, resident in London for ten years, who had at one time served in the army in Malta, but have since never left the British Isles. The clinical evidence all pointed to the presence of pus in the gall-bladder, but when the abdomen was opened, an abscess reaching from the anterior to the posterior border of the liver parallel and to the right of the gall-bladder was found. The abscess was opened and drained by an opening both in front and behind near the angles of the ribs. The patient recovered.

Case 4. *The Effect of Sterile Pus in the Cavity of the Abdomen.*—A sailor, aged 35, recently in the Royal Navy, had to leave his ship with all the signs and symptoms of liver abscess. At first he refused to be operated upon, and it was not until the severity of the illness became alarming that he consented. On cutting down upon the swelling in the right hypochondrium an abscess was found on the under-surface of the liver; the wall of the abscess had attained adhesion to the peritoneum in the right lumbar region, and the pus extended as low and as far back as the upper end of the right kidney which was incorporated with the swelling. Moreover, the pus had burst into the cavity of the peritoneum. The contents of the abdomen from diaphragm to pelvis were covered over by a slimy, muco-purulent-looking fluid. There were no signs of peritonitis, no adhesions, no flocculent pus, nothing except this passive effusion of slimy, muco-purulent-looking fluid in great quantity. The pus from the abscess cavity and the semi-fluid material from the surface of the peritoneum were examined bacteriologicaliy, and both were pronounced sterile. This is, so far as I know, the first recorded case of the kind, and it is of special interest.

The treatment in this case consisted of free incisions in the abdomen in right and left lumbar regions, and in the middle line below the umbilicus, flushing the abdominal cavity with saline solution, and the insertion of large drainage tubes. The liver abscess was drained separately. The patient is now (June 11th, 1906) convalescent.

Case 5. — A man, aged 37, resident all his life in Britain, had signs and symptoms of abscess of the liver in 1904. The abscess was not operated upon, and the pus burst upwards through the lung. The expectoration of pus ceased, and the patient for a time was fairly well. After four months the local signs and symptoms returned, and again he went into hospital; no operation was performed, and again he seemed to recover, but without any expectoration of pus. He continued to have hepatic pain and fever at intervals until May, 1906, when I found him with increased temperature, an epigastric swelling, local pain, and general discomfort. After five days he came into hospital, by which time the swelling had disappeared, the temperature had fallen to normal, and the patient said that the day before he came into hospital he had passed at stool a large quantity of "the same material he had on a previous occasion coughed up." It was plain the abscess had burst into the bowel, the colon in all probability. So far as I can learn, this is the only instance of a hepatic abscess which has been known to burst in two directions, namely, upwards through the lung and subsequently downwards into the bowel.

When cut down upon, an abscess was found on the under-surface of the left half of the liver near the posterior border; the liver, stomach, and colon being adherent to the wall of the abscess. The treatment consisted in exposing the swelling, packing the wound, and at the end of a week opening and draining the cavity. The pus from this abscess was sterile—a peculiar and most unexpected condition, seeing that there had been a double source of possible contamination, namely, by way of the lung and by way of the bowel. The patient is still under treatment.

THE ANATOMY OF THE BITING FLIES OF THE GENERA *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Rtd.).

(*Continued from p.* 173.)

The œsophagus, after its commencement in the pharynx is a rather delicate tube. As seen in fig. 24, A, it is lined with an extremely delicate membrane, which is probably smooth in the fresh state, but is much wrinkled as seen in a transverse section on account of the shrinking action of the reagents employed on the softer tissues. In some of the folds thus produced there will always be found minute bodies which stain strongly with nuclear dyes and possibly are nuclear bodies. The main thickness of the walls of the tube is, however, formed of a ring of faintly granular material which shows fairly clearly a longitudinal striation, as seen in transverse section. These fibres are probably muscular. In the same sheath with these and lying always towards the lumen of the tube are some oval nuclei provided with a distinct nucleolus.

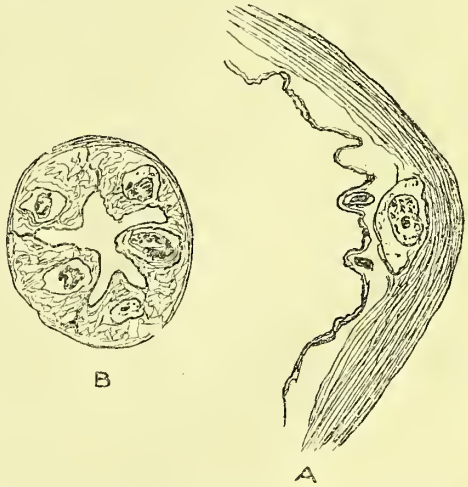


Fig. 24.—A, portion of wall of free œsophagus in transverse section: B, transverse section of the œsophagus as it passes through the nerve collar.

There are rarely more than two of these, usually almost opposite each other, in a fairly thin transverse section of the organ, and I believe them to be muscle nuclei. Outside these are some scattered cells of about the same size as these muscle nuclei, but they do not seem to be concerned in the structure of the tube, and are more probably lymph cells.

The narrow portion of the œsophagus, when it passes through the nerve collar, has a very different structure. The muscular and chitinous coats are both so thin as to be barely perceptible, and the place of the small nuclei, to be seen between the folds of the chitinous inner lining of the first part, seems to be taken by a continuous coat of large cells which have the appearance of epithelial elements. The lumen is here stellate in transverse section, and, on account of the size of the above-mentioned cells, extremely contracted.

The histology of the nerve centres does not differ from that of other diptera, a prominent character of which is the smallness of the component cells. In the layer of grey matter that surrounds the white commissural masses, two distinct forms of cells can be distinguished. In one of these, which one would be inclined to believe motor in function, the structure consists of multipolar cells, usually about the diameter of a human leucocyte. They have large nuclei, but still possess a considerable volume of protoplasm. Their prolongations give off fibres which occasionally can be traced for some distance. A good example of a ganglionic mass of this structure is to be found on the surface of the ventral nerve cord in the middle line.

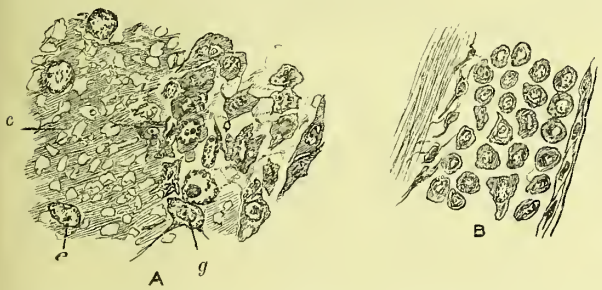


Fig. 25.—A, Portion of the ventral commissure and of the motor median ganglionic mass in that situation; *c*, commissural structure; *g*, motor ganglion cells; *e*, elements embedded among the commissural fibres. B, Cortical layer of anterior surface cerebral lobe.

The greater part of the sides of the cerebral masses is occupied by the ganglia of the compound eyes, the retinulæ of which are continuous with the cerebral mass, but this has been too frequently described to render desirable any further description here. An account, running to some 70 pages, will be found in Lowne's work already quoted, commencing p. 515.

On the anterior surface of the brain, however, between the compound eyes, is a ganglionic layer which is probably sensory in function. The component cells of this are quite different from those of the presumed motor areas, the cells being smaller (about the diameter of a human red blood corpuscle) and apparently for the most part quite without prolongations, though a few scattered cells of larger size show an irregular outline, which suggests the existence of these. There are four or five rows of these, and between them and the white matter lies a row of very small and distinctly multipolar cells. The outer surface of the brain is bounded by a membrane formed of closely adherent spindle-shaped cells, with large oval nuclei. In other places the thickness of the ganglionic masses may be as much as 20 or 30 rows of cells deep. In using the word "row" it is not implied that the cells are arranged in regular strata, as their disposition is quite irregular, but refers merely to the number of cells which may be counted in the width of a section. In specimens stained with borax carmine, a number of black pigment granules will be seen in these cells, and impart to them a very characteristic appearance, which is useful in recognising similar ganglion cells, in other situations than the brain, as, for instance, in the subcuticular tissue, beneath the sense organs of the antenna, but in staining with hæmatin and most of the aniline dyes, they cease to be distinguishable, on account of similarity of colouration with other deeply stained granules. Between the various bands of fibres of the white matter, may be found a number of ganglionic masses, composed of cells of each of the above descriptions, though the motor type predominate. Lastly, scattered between the fibres are a number of large clells or nuclei (*e*), presenting a large, clear, central area, and round their periphery a number of deeply staining granules, but these are probably not nervous structures at all, but of a trophic function.

In Mr. Austen's monograph of *Glossina*, mention is made (p. 63) of a sense organ placed near the base of the third joint of the antenna, but without any detailed description of its structure. In the corresponding position in the antenna of *Stomoxys* a similar organ is to be found, which, though I have made no examination of it in the former genus, has probably a similar structure. Judging from Lowne's figures, this organ is represented also in the blow-fly, but differs somewhat in details of structure.

In *Stomoxys* the aperture of the organ is oval and is hidden by closely set, long, flexible hairs. This slit opens into a sausage-shaped saccule, within which is a T-shaped projection which springs rather from the anterior side of the saccule, the stem being short and the top of the letter long and generally conforming to the outline of the cavity, so that it appears as an isolated piece in transverse sections that pass elsewhere than in the plane of the stem. The whole of this cavity is lined with peculiar stiff hairs, the bases of which are short and conical, while they end in a long bristle. These chitinous structures overlie a layer of ganglionic cells, from each of which a fibre runs to a hair, while proximally each ganglion cell receives a fibre from a ganglionic enlargement of the antennal nerve, which fills up the greater part of the cavity of the second antennal joint. The function of the organ is probably that of hearing. In addition to the saccule the whole surface of the organ is covered with sensory hairs, each of which has a similar nerve supply, and in the neighbourhood of the sacule are a number of peculiar sense organs of a quite different character. A number of these are to be found amongst the bases of the long soft hairs that guard the mouth of the saccule, while many others of considerably larger size are contained in a porous plate on the outer face of the antenna which is comparatively free from hairs. Though varying a good deal in size, even in the porous plate, they all have essentially the same structure, and consist of an ovoid crypt, communicating by means of a pore with the exterior, and springing from the base of which is

a club-shaped body which fills most of the interior of the crypt. From the club-shaped end of this body springs a soft conical hair, the fine termination of which projects into the pore. Two rows of very large organs of this sort are also to be found on the posterior face of the antenna. The nervous supply of these peculiar structures is exactly similar to that of the other hairs. They are believed to be olfactory organs, but in view of their graduated size it would be open to any one to suggest that they are chordotonal

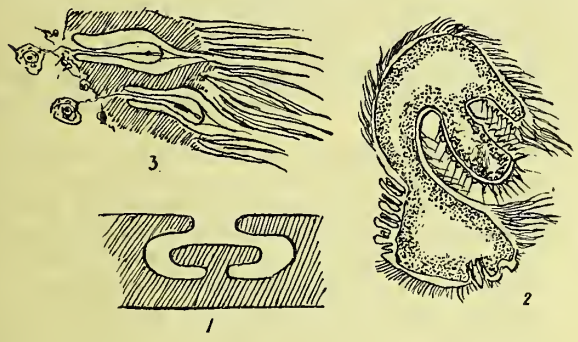


FIG. 26.—The sense organs of the antenna. (1) Diagrammatic longitudinal section; (2) transverse section, × 250 diams.; (3) vertical section of position of outer wall of antenna, × 700 diams.

organs. That certain insects lose the sense of smell, when deprived of their antennæ, has been fairly proved by Lubbock and others, but as to which of the various sense organs found on the appendage may serve this or that function must always remain a matter of pure conjecture.

The thorax in all diptera is little else than a solid mass of muscle. If we snip off with sharp scissors, the legs, with a little of the ventral wall of the thorax, the ends of a number of vertical bundles are seen cut across. These are the coxal muscles of the three pairs of legs, and if these be separated in the middle line there will be seen opposite the anterior legs a sausage-shaped mass of considerable size, the great thoracic ganglion. Clearing this away and just under its anterior end will be seen a nodule of the size of a small pin's head, and closer inspection will show that there extends backwards from it a glistening tube which is most characteristically marked with closely placed mammilations. This is the mid-gut, and lying on it will be seen three delicate tubules, the middle and most delicate of which is the crop duct and those at the sides the now glandular salivary glands. The mid-gut can be traced forwards beyond the nodule, and with sufficient care can be shown to be continuous with the œsophagus, as it escapes from the nerve collar. The nodule is placed at the junction of the stomodæum with the mid-gut, and is known as the proventriculus, a very peculiar organ, which will be described in detail further on. If these parts be removed it will be seen that all else is muscle. Pressing apart the masses in the middle line, layer after layer (four in all) of longitudinal muscle can be clearly seen, filling up the greater part of the space. Further out there are numerous more or less obliquely vertical bundles. The whole constitute the muscles of flight; for the wing roots are not acted on directly by the muscles, as is the case with the ventral appendages, but in a very indirect manner by their action in producing an alteration in the form of the chitinous exoskeleton of the thorax, and thereby actuating a complicated series of sclerites which are connected with the wing roots. Any attempt to describe these muscles and their action here is, however, clearly out of place; and indeed, though much has been written on the subject it is very doubtful if any one has yet solved the problem of their mechanics.

The thoracic ganglion is mainly contained in the mesothorax just above its sternum, but the oval ends extend before and behind into the contiguous portions of the pro- and meta-thorax. Sections show that there are three principal ganglionic masses: a median commissural ganglion, which is divided into three parts, and lateral ganglia which are so continuous as to leave but little indication of the original separation into the ganglia of the three thoracic somites. The lateral branches of the ganglion have separate sensory and motor roots, and ends behind in a median and lateral branches which extend into the abdomen. There does not appear to be any difference in the anatomy of the nervous system from those of other flies, and those who desire a description of its details should consult some standard work on general dipterous anatomy, such as Lowne.

The proventriculus is a very peculiar structure which forms a sort of three-way junction between the œsophagus, crop duct, and mid-gut, and is situated in the prothorax, lying upon the cephalothoracic nerve cord and the front of the thoracic ganglion. Apart from certain differences of moulding, it is essentially the same in all Muscidæ, so

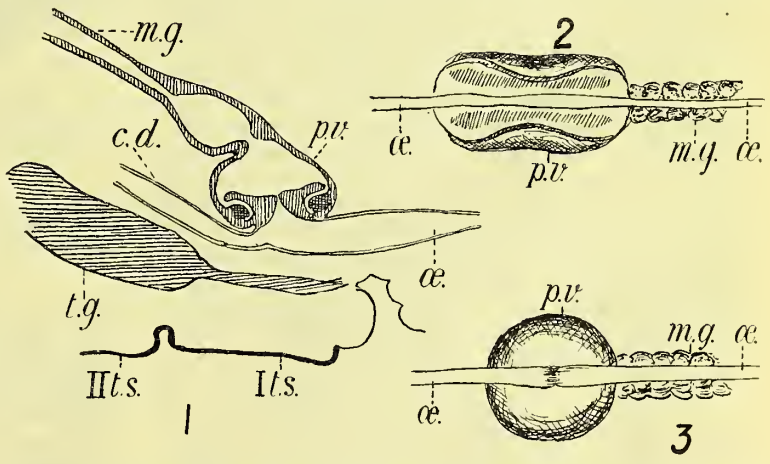


FIG. 27.—(1) Camera lucida drawing of a sagittal section of the proventriculus of Stomoxys and its connections, × 50 diams.; (2) and (3) freehand drawings of the proventriculi of *Glossina palpalis* and *Stomoxys calcitrans* respectively viewed from below; *Its*, *IIts*, first and second sternal sclerites; *cd*, crop duct; *mg*, mid-gut; *œ*, œsophagus; *pv*, proventriculus; *tg*, thoracic ganglion.

that our description of the organ will, with a few added words as to differences, serve equally well for *Stomoxys* and *Glossina*. The body of the organ consists of a fairly thick-walled bulb, from the dorsal surface of which springs the mid-gut, while the crop duct and œsophagus are connected with the ventral.

As will be seen from an inspection of fig. 1, the organ in *Stomoxys* closely resembles a retort, the beak of which is formed by the mid-gut.

The œsophagus and crop duct, which really form a continuous tube, give one the impression of entering the under-surface separately, as seen in dissecting, but do not really do so, the illusion being produced by the actually continuous tube being tucked up into the funnel-shaped aperture in the lower surface of the proventriculus.

In *Glossina* the junction is T-shaped, and there is a distinct vertical duct which runs up from the upper surface of the junction between the œsophagus and crop duct, so that, even to the dissector, the continuity of the latter is quite obvious. In both genera, however, the vertical diverticulum enters the proventriculus by piercing the centre of a very peculiar structure, which has exactly the form of a bone button, the sewing which would attach such a button to the cloth being represented by a stout peduncle, through which the vertical diverticulum passes to enter the cavity of the proventriculus. Concealed beneath the margin of the button is an annular thickening of the floor of the cavity, which is formed of peculiar clubbed cylindrical epithelial cells.

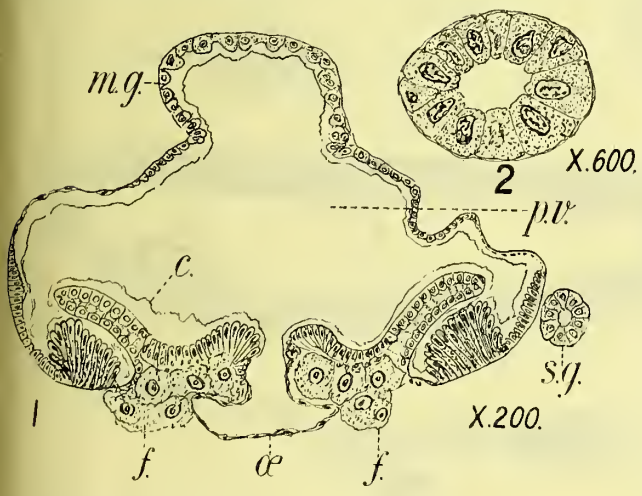


Fig. 28.—(1) Transverse section of proventriculus, × 200 diams; (2) transverse section of salivary glands; *c*, chitinous lining membrane; *f*, fat body; *mg*, mid-gut; *œ*, œsophagus; *pv*, cavity of proventriculus; *sg*, salivary gland.

A ring of somewhat similar structure, in the middle of the upper surface of the button, surrounds the almost punctiform opening of the vertical diverticulum. The lining, indeed, of this curious structure presents a sort of epitome of the various types of epithelial cell. Both surfaces of the remainder of the button are paved with cubical cells; outside the thickening beneath it the floor of the cavity is composed first of cubical and then of columnar cells; the lower part of the vault is composed of elements of the squamous form, and these change again to the cubical type, which, in its turn, gradually changes to the much larger irregular glandular type of cell which lines the commencement of the mid-gut.

The œsophagus and crop duct may be taken as chitinous stomodæal tubes, and it is a curious circumstance that this chitinous lining is continued through the vertical diverticulum into the proventriculus, and lines its entire cavity, though there appears to be no organic connection between this lining and the epithelial coat already described.

Though extremely delicate the structure is perfectly definite and continuous; and though fluids doubtless easily osmose through it, it seems rather difficult to understand how the products of the epithelial waste are disposed of. Taking the structure as a whole, it is difficult to resist the idea that it must, in some way, have a valvular function, though it is difficult to say how. The button is a solid mass of epithelia, and a most careful search through many series of sections has entirely failed to demonstrate any muscular components. The only way in which the puncture can be imagined to be closed by the structures as they stand is that the ring of club-shaped epithelia, beneath the button, if secreting actively, might swell and so cup the button more deeply, and that any such alteration of form would certainly tend to close the puncture. Weismann believes it to be glandular, and Lowne regards it as a gizzard, and there can be no doubt, as the latter points out, that it is homologous with the gizzard of manducatory insects, but it is difficult to see what a blood-sucking insect wants with such an apparatus, and as a matter of fact, but little changed red corpuscles of the victim are constantly to be found on the mid-gut.

In *Stomoxys* the proventriculus opens into the mid-gut by a very narrow opening, followed immediately by a bulb-like dilatation; after which the gut contracts to a uniform diameter for the rest of its passage through the thorax, but no such dilatation appears to exist in *Glossina*. In this genus, too, the button is oval instead of circular, and the entire organ is oblong with rounded corners and very slightly contracted in the middle. In addition to this (fig 27, ²), whereas in *Stomoxys* the organ is convex below in all directions, in *Glossina* the sides are curled round to protect the œsophagus and crop duct, so that, seen from below, it has much the form of a Spanish priest's hat.

The salivary ducts, almost immediately after entering the thorax, change from minute chitinous tubes to large tubular glands, and run back below the œsophagus to the sides of the proventriculus, and then below the digestive tubes to the abdomen. They are 0·08 mm. in diameter, and are lined with a cubical secretory epithelium, the components of which assume a keystone form on account of the smallness of the lumen. They have large nuclei with prominent chromatin fibres, and show neither anything in the way of a basement membrane nor any chitinous lining (fig. 28, ²).

On the dorsal side of the digestive tube, and lying in absolute contact with it, is the aorta, but the peculiarities of its structure will be better described in connection with the abdominal dorsal vessel.

(*To be continued.*)

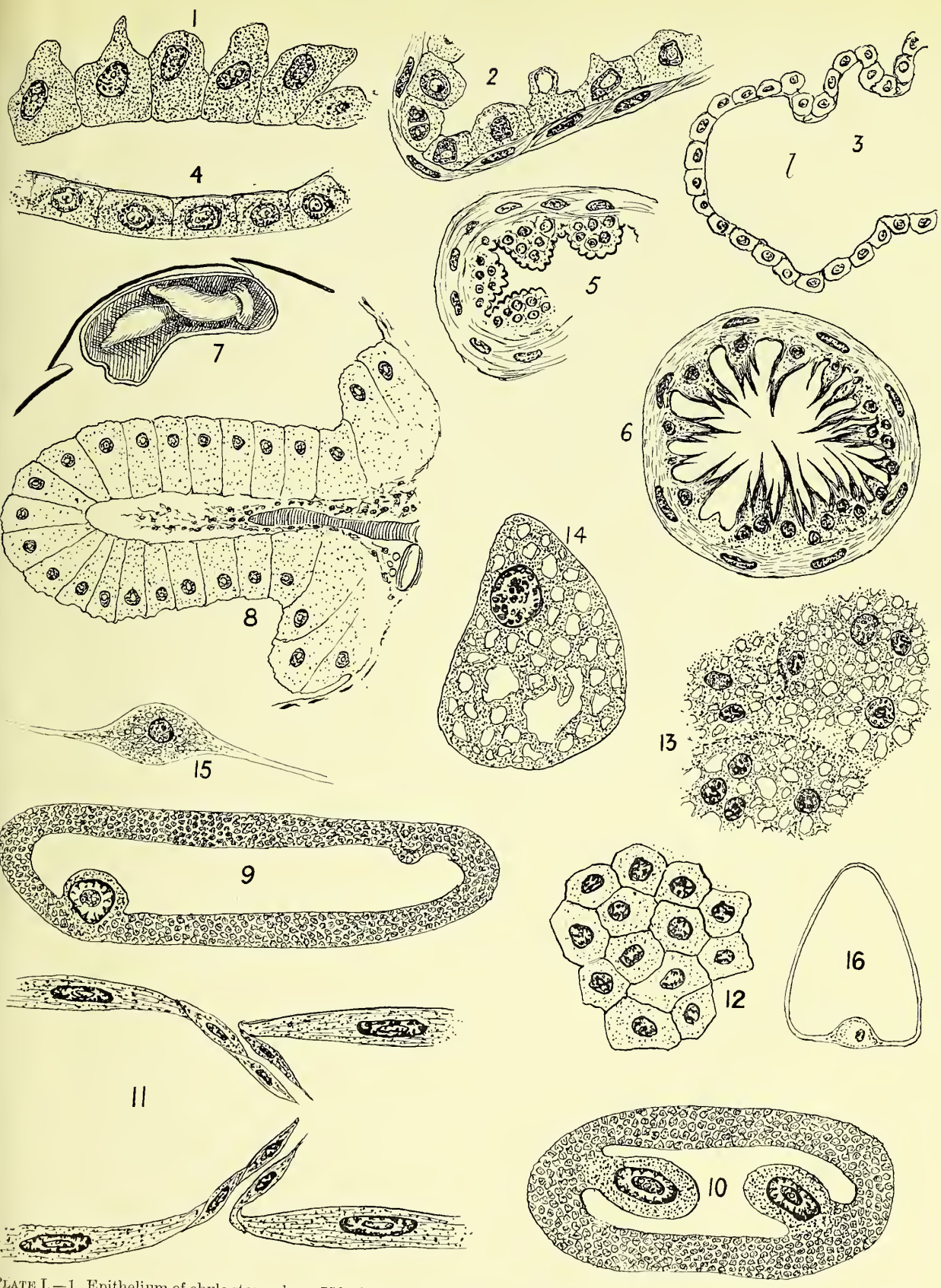


PLATE I.—1, Epithelium of chyle stomach, × 750; 2, vertical section, upper part of proximal intestine, × 750; 3, vertical section, lower thin part of proximal intestine, × 270; *l*, lumen of intestine; 4, the same, × 750; 5, vertical section, upper part of metenteron, × 270; 6, vertical section, lower part of metenteron, × 270; 7, drawing in perspective of rectal papillæ as seen in a dissection of the rectum which is laid open, × 37; 8, vertical section of a rectal papilla, × 270; 9, transverse section of heart of Stomoxys, × 270; 10, tranverse section of heart of Glossina, × 270; 11, semi-diagrammatic representation of valves of heart of Stomoxys, × 270; 12, pavement endothelium of pericardial septum, × 270; 13, portion of fat-body, × 550; 14, "pericardial cell" fat-body type, × 750; 15, pericardial cell, Lowne's muscular type, × 750; 16, transverse section, thoracic aorta, × 1,500.

To illustrate article by Lieut.-Col. G. M. GILES, I.M.S., "The Anatomy of the Biting Flies of the Genera *Stomoxys* and *Glossina*."

drainage and filling in swamps. A great deal is now being done on most of the estates by regular administration of quinine, and also by protection from mosquitoes.

Malaria in children as evidenced by Examination of blood.—No better indication of the presence or absence of malaria in any given district can be obtained than by a systematic examination of the blood of children.

The following details of the results of examinations carried out by Dr. Watson in 1904 and 1905 are of considerable interest:—

Results of Examination of Blood of Children in Klang and Port Swettenham (specially Drained Areas).

	Nov. and Dec., 1904			Nov. and Dec., 1905		
	No. Examined	Infected	Percentage Infected	No. Examined	Infected	Percentage Infected
Klang..	173	1	0·57	119	1	0·84
Port Swettenham ..	87	1	1·14	76	0	0·00
Total	260	2	0·76	195	1	0·51

Results of Blood Examinations in other Parts of District not especially Drained.

Nov. and Dec., 1904			Nov. and Dec., 1905		
No. Examined	Infected	Percentage Infected	No. Examined	Infected	Percentage Infected
298	101	33·89	247	59	23·8

Improvement in Health of Government Employées.—The remarkable way in which the health of the Government employées residing at Klang and Port Swettenham has been affected is well shown by the following figures. It may be mentioned that in 1901 the number of persons residing at Port Swettenham, employed by Government, was 176, and in 1904, 281.

Table showing Number of Sick Certificates and Number of Days' Leave Granted on account of Malaria.

	1901	1902	1903	1904	1905
Certificates	236	40	23	14	4
Days of Leave	1,026	198	73	71	30

The conclusions to be arrived at from the figures given in this report are very evident:—

(1) Measures taken systematically to destroy the breeding place of mosquitoes in the towns, the inhabitants of which suffered terribly from malaria, were followed almost immediately by a general improvement in health and decrease in death-rate.

(2) That this was due directly to the works carried out, and not to a general dying out of malaria in the district, is clearly shown by figures pointing out that while malaria has practically ceased to exist in the areas treated, it has actually increased to a considerable extent in other parts of the district where anti-malarial measures have not been undertaken.

The fact that the statistics for 1905 are even more favourable than those for 1902 is very strong evidence in favour of the permanent nature of the improvement carried out.

If, as it is hoped, malaria has been permanently stamped out from Klang and Port Swettenham by works undertaken in 1901, our experience in the Malay States should be of value to those responsible for the health of communities similarly situated in many other parts of the world.

THE ANATOMY OF THE BITING FLIES OF THE GENERA *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Rtd.).

(*Continued from p.* 185.)

The abdomen is a good deal shorter than the wings, and, seen from above, appears to be composed of only four segments, the juncture between the first two being hidden and the remaining four concealed by being curled under in the male or hidden in the telescoped ovipositor of the female. In the gorged insect, the whole of the ventro-anterior portion of the cavity is taken up with the enormous crop, which in males, when distended, occupies almost the entire space, leaving the other viscera crowded into a comparatively small space behind and above it. When empty of food it contains a certain amount of air, and Lieut. Tulloch's account, transcribed below, must be taken as referring to it in this condition: As his admirable account, which entirely agrees with my own observations, is very brief and to the purpose, I cannot do better than transcribe it, altering the nomenclature, where necessary, to that hitherto employed. He says:—

"The midgut runs down into the abdomen of the fly as a narrow tube of uniform diameter until it reaches nearly to the posterior border of the crop. At this point it dilates to several times its former diameter, its wall at the same time becoming thinner. It is proportionately shorter, less coiled, and more distensible than in *Glossina*, being about three times as long as the fly itself. This dilated portion has three simple coils, which lie superposed in the middle of the abdomen, and it then gradually narrows, continuing as a uniformly narrow tube down to the rectum. The narrow lower intestine has variable bends, but is not coiled. The rectum is a dilated cone-shaped cavity, with its apex towards the anus. Its walls are transparent, and through them are seen the four trumpet-shaped rectal papillæ, the narrow ends of which are pointed towards the anus, a single trachea entering the base of each. Below the dilatation, the rectum is continued to the anus as a short, narrow tube. In the female the distal part of the rectum runs within the ovipositor, the anus opening between the last segment of the ovipositor and the terminal plate. In the male the ejaculatory duct passes over it dorsally from left to right and runs anteriorly to enter the penis. The appendages of the alimentary canal are the Malpighian tubes, the crop and the salivary glands. The Malpighian tubes arise from a

shallow constriction which marks the point of junction between the midgut and metenteron, and it, together with the true proctodeum, comprises in length about one fifth of the abdominal intestinal canal. Two of the tubules arise on either side from a short, common tube, all four being about the same length. The two arising from one side have thickened terminations, some four times greater than a

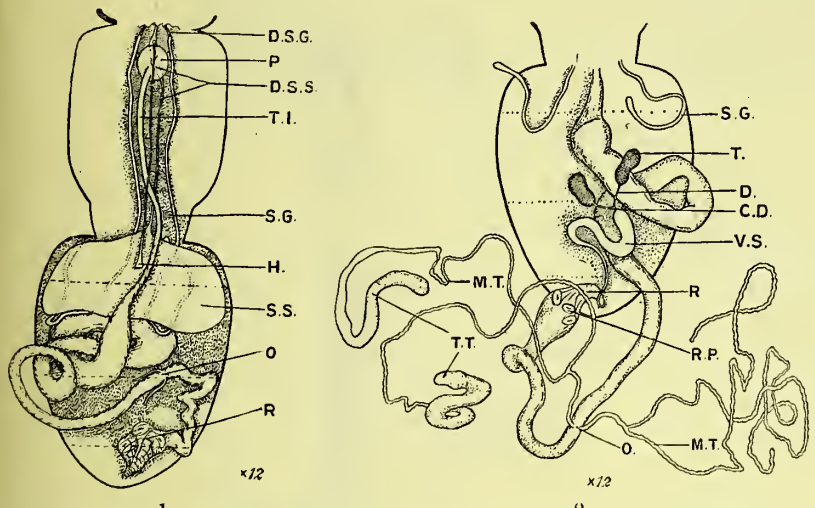


FIG. 29.—Dissections of the abdomen of *Stomoxys*, after Lieut. Tulloch, seen from above :—(1) with the parts almost *in situ*; (2) with the alimentary canal unravelled; CD, common seminal duct; D, seminal duct; DSG, duct of salivary gland; DSS, crop duct; H, dorsal vessel; MT, malphigian tubes; O, junction of distal intestine and metenteron; P, proventriculus; R, rectum; RP, rectal papillæ; SG, salivary glands; SS, crop; TI, chyle duct; *tt*, dilated ends of left malphigian tubes; VS, vesicular seminalis.

salivary gland, and lie in the pericardial sinus; those of the other are of uniform thickness, and end amid the fat body of the lower abdomen. The salivary glands in the abdomen are ventral to the crop, and seen from above only a knuckle of each projects beyond it, and then turned forwards to end close to the waist in slightly bulbous ends. Except for this angular bend the glands are straight, and even if extended, would not reach to the end of the fly.

Throughout its length the mucosa of the intestinal canal is composed of a single layer of epithelial cells. The wide thoracic portion of the midgut of the blow-fly, called by Lowne the chyle stomach, is in *Stomoxys* a quite narrow tube, though it has the same structure as in the former insect. Both it and the wide proximal intestine is composed of a layer of cells whose components vary a good deal in size and form, according to the stage of secretory activity in which they have been fixed. In the thoracic portion the muscular coat is fairly distinct, and both the longitudinal and circular fibres are arranged at intervals, leaving spaces where there is only epithelium; but the pouching out of the lining into these spaces is by no means as marked as in the blow-fly, so that even in proportion to its size this part of the gut has not as strongly granular an appearance when viewed with a dissecting lens. The dilated part of the proximal intestine has an epithelial lining (plate i., fig. 1) of much the same character, and both in it and the narrow transparent part that follows it the muscular coat is very ill marked, and often appears quite absent in sections; though where the transition to the structure of the narrow part occurs, the circular coat becomes very distinct (fig. 2). The narrow part is lined with cubical cells of regular form (figs. 3 and 4), and has a very distinct limiting membrane towards the lumen of the tube.

The metenteron, on the other hand, is strongly muscular, and is structurally divisible into two distinct portions. For the first and greater part of its length it is lined with a distinct cuticular lining, the epithelial elements of which are scarcely discernible. In the ordinary contracted condition of the tube, this is wrinkled into deep folds, in the interior of which are strong longitudinal muscular bands (pl. i., fig. 5), and outside these is an equally strong coat of circular muscular fibres. The last short portion before the rectal valve is of similar structure, but here (fig. 6) the cuticular lining has become distinctly chitinous, and has developed into a curious armature of powerful spines, the function of which I am unable to conjecture. There is, however, nothing generically peculiar in this structure, which is, I believe, found throughout the Muscidæ. The "rectal valve" between this portion of the intestine and the rectum is lined with similar spines, and is surrounded by a muscular thickening. At first the rectum is tubular, and its chitinous lining has a distinct basis of cubical epithelial elements; but after passing a quasi-sphincter formed by a thickening of the muscular coat, it expands into a large cavity which lies on the right side just under the interior abdominal terga. This dilated portion of the rectum is lined by a delicate chitinous membrane, the epithelial basis of which is not easily demonstrable, and is covered with a network of muscular fibres closer meshed, but of the same general character as that of the crop. This dilatation contains the four rectal papillæ, which are four cylindrical projections ending in blunt conical points, lying two and two lengthwise in the intestine. They resemble a good deal the rectal gills of certain aquatic larvæ, but according to Lowne subserve the renal function, as he has found in them a substance related to uric acid. Their general form may be seen from the dissection (plate i., fig. 7) of the two right-hand papillæ (the figure being reversed), and in section (plate i., fig. 8) are seen to be formed of very large columnar cells surrounding a core of delicate mesodermic tissue in which is imbedded a large trachea. Behind the papillæ the rectum contracts to a mere slit, and the absolute anus is guarded by a strong sphincter of unstriped muscle.

The malphigian tubes which enter the bowel at the point of junction of the proximal intestine with the metenteron hardly differ from those of the mosquito even in size. Their large pigmented cells and slit-like lumen, zig-zag longitudinally, must be familiar to most students of tropical medicine from their dissections of those insects. Lowne advances strong reasons for believing that

their function is hepatic, and not, as usually supposed, renal.

The crop has an elastic pigmented chitinous membrane covered with an open and rather irregular network of unstriped muscle, and its ventral side is connected with the abdominal sterna by a number of single obliquely-directed striped muscular fibres. Its whole structure is such that though clearly contractile, it is obviously absolutely incapable of active dilatation, so the name of "sucking stomach," which is sometimes applied to it, should be carefully avoided.

In *Glossina* the abdominal intestine is longer, larger, and in every way more voluminous, and the secretory area of the dilated portion has its surface enormously increased by deep infoldings of very large epithelial

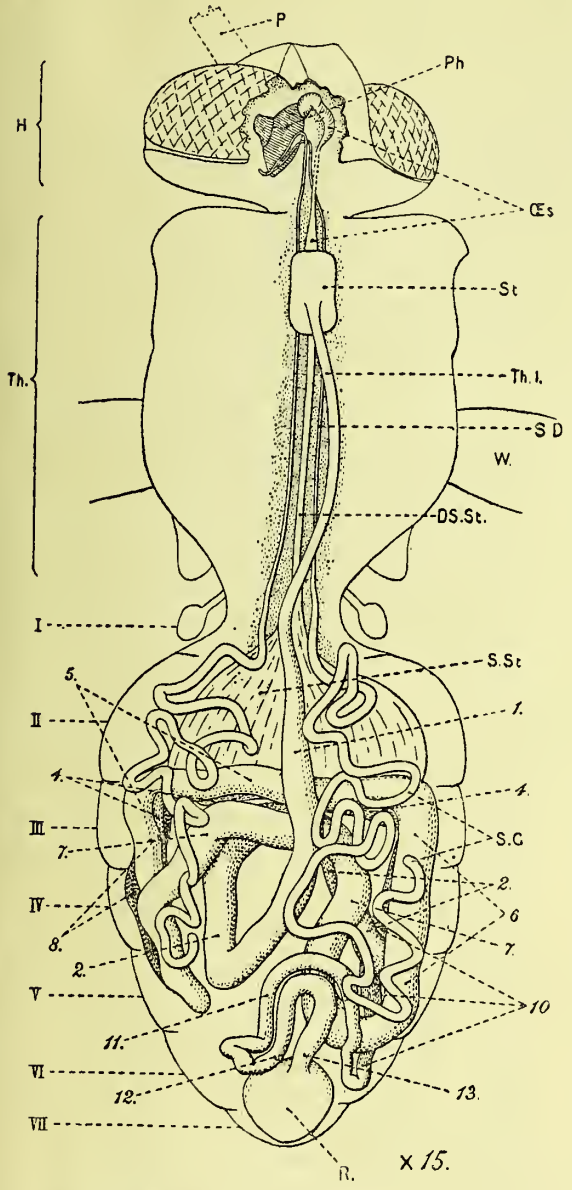


FIG. 30.—General view of the digestive tract of Glossina palpalis, as seen in dorsal view without disturbing its parts. The heart and over-lying tracheæ and fat-body are removed in the abdomen, also the muscles in the thorax, and the brain and other parts of the nervous system are omitted from the drawing. The head is turned round to the left, in order to show the pharynx, &c., in three-quarter side view. *Ph*, pharynx; *Œs*, œsophagus (the portion which passes through the brain being represented with a dotted outline); *St*, stomach; *Th*, *I*, thoracic intestine, pulled over to the right, in order to show the duct of the crop lying beneath it; *S*, *D*, salivary duct; *DS*. *St*, duct of; *S*, *St*, the sucking stomach; *S*, *G*, salivary gland (that on the right is drawn from a specimen in which the gland was more developed than in the case of that drawn on the left); 1 13, limbs of the abdominal intestine (see fig. 31); *R*, rectum. (After Minchin.)

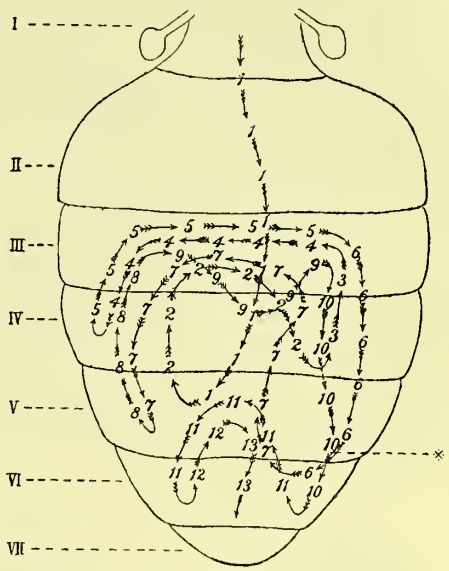


FIG. 31.—Diagram to show the various limbs (1—13) of the abdominal intestine, and their arrangement in the abdomen. The asterisk * denotes the point at which the Malpighian tubules arise in the tenth limb. (After Minchin.)

elements. The two figures herewith reproduced from Professor Minchin's paper will, in the light of what has been said of the allied species, give a sufficient idea of the arrangement of the parts, and as he proposes to write a paper on the histology of the genus, any further discussion of the subject here is superfluous.

The enormous development of the intestine is somewhat surprising in a species subsisting on so nutritious a diet as blood.

The vascular system.—What is found by the writer the readiest plan of demonstrating the dorsal vessel of a dipterous insect is to compress the insect between the fingers and thumb, at the same time, as far as possible, strengthening out the dorsal curve, and then to snip off the mid-dorsal portion of the abdomen by a single stroke of a pair of sharp scissors.

The portion removed is then placed in water, under the dissecting microscope, and as much as possible of the fat body picked away. The facility of this latter operation, however, differs greatly in different species, but is especially difficult in *Stomoxys*. Lieut. Tulloch, in his paper, notices this point. He says:—

"Though several stained preparations were made, it was impossible, owing to the fat body, which obscured all detail, to count the chambers and cells in the heart wall. They seemed, from a comparison of all preparations, to be re-

duced in proportion to the smaller number (four) of abdominal segments possessed by *Stomoxys*."

As compared with *Glossina*, I am inclined to agree with Lieut. Tulloch as to the number of chambers, but must confess great uncertainty on the point.

Referring to *Glossina*, Prof. Minchin writes as follows :—

"The vascular system consists of the heart, in the abdomen, and its continuation, the thoracic aorta, in the thorax.

"The heart occupies the five anterior segments of the abdomen, and is situated dorsally immediately below the plates of the terga. It is so imbedded in the fat body and pericardial tissue that not much can be made out of its structure by dissection alone, and examination of it mounted as a preparation for the microscope is necessary. It can then be seen to have five chambers, each with a pair of ostia and a pair of alary muscles, corresponding to the segments in which it lies. The alary muscles pass out at right angles to the axis of the heart, and can be traced through the fat body to their attachments at the external lateral margins of the tergal plates.

"The hindermost chamber of the heart appears to end blindly posteriorly. A little way in front of the hinder end are attached the two large alary muscles, the largest of the whole series; not far in front of these again are the two ostia, on the sides of the widest part of the chamber. In front of the ostia the lumen of the heart narrows rapidly, and to the narrow portion is attached the next pair of alary muscles, lying in the hinder part of segment 4. This arrangement is continued in segments 2, 3, and 4, the dilated portion of the chamber, with the ostia, occupying the middle of the segment, while the alary muscles, attached to the constrictions between the chambers, lie in the posterior regions of the segments. The alary muscles of these three segments are of moderate size. In segment 2 the heart receives a pair of tracheal tubes, right and left, which come to it opposite the ostia, and fork at once into branches running forwards and backwards. The alary muscles corresponding to the first abdominal segment are very small and difficult to make out, and the region of the heart to which they are attached does not show the slightest diminution or constriction of its lumen, as is the case in all the chambers posterior to it. In front of the first pair of alary muscles, at the usual interval, are the two ostia, quite similar to those of the other chambers. In front of the first pair of ostia the lumen of the heart narrows to form a thin-walled vessel, which passes through the waist to become the artery which I have termed above the thoracic aorta. This last runs along the thoracic intestine on its dorsal side, and is continued over the stomach, remaining apparently quite independent of the digestive tract, and only loosely attached to it, until it reaches the œsophagus. Here it is firmly attached and becomes considerably dilated. A short distance in front of the stomach a conspicuous cushion-like mass of large cells lies over the aorta. At first I took this structure for a ganglion, but it appears to be a sort of lymphatic gland, judging from its appearance in sections. The thoracic aorta is apparently continued through the neck into the head, but I have not been able to follow its course further than the thorax.

"The microscopic examination of the heart shows further that its floor is composed chiefly of fusiform cells resembling unstriped muscle fibres, while its sides are made up of gigantic cells with nuclei of corresponding proportions. These cells are arranged with perfect regularity, and in a manner exactly similar on the two sides of the heart. Each ostium is formed by two cells, which are of small size when compared with the huge cells building up the wall of the heart, but are very large when compared with the cells of the surrounding tissues. Two of the giant cells intervene on each side between the hinder end of the heart and the fifth pair of alary muscles; two more between these muscles and the ostia next in front of them; and so on with unfailing regularity all the length of the heart, each ostium being separated from the alary muscles next in front or behind by just two giant cells. In front of the first pair of ostia are found two cells of the usual size on each side, then a pair of slightly smaller cells, which pass on into the walls of the thoracic aorta. Thus the entire wall of the heart is built up of 23 pairs of giant cells, not counting the ten couples of smaller cells which compose the five pairs of ostia: to wit, four pairs to each of the five chambers, two additional pairs behind the fifth pair of alary muscles, and one pair anteriorly, making the transition to the thoracic aorta. In view of the fact that the thoracic vessel is itself to be considered as a modified anterior portion of the heart, it is interesting to find that its delicate wall contains very large, flattened nuclei, arranged in pairs right and left.

"The alary muscles consist of delicate fibrils, arranged in an irregular fan-like manner, uniting into a stout muscle-fibre which is distinctly striated."

The above description, in the main, applies equally well to *Stomoxys*, and is in entire agreement with such observations as I have made on *Glossina*, except as to the floor of the heart being composed of "fusiform cells resembling unstriped muscular fibres." It is believed that the statement is referable to the appearances presented by dissected specimens, which always include the pericardial septum, which, seen in optical section, certainly conveys the impression described. As the result of the examination of sections, the writer believes that Lowne is correct in describing the dorsal vessel of Diptera as a hollow muscle, composed at the most of two cells in any single transverse section.

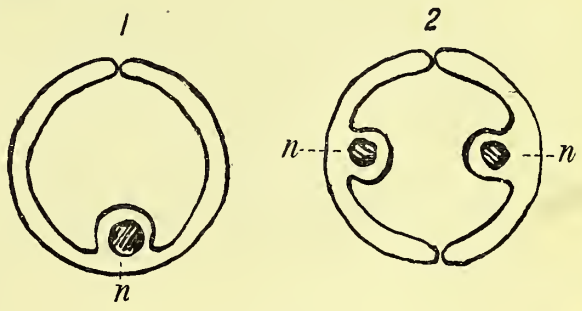


Fig. 32.

Lowne's conception of the heart of the blow-fly, as gathered from his book, may be diagrammatically represented as in fig. 32, each large nucleated cell being provided with lateral expansions which meet above in the middle line. In *Glossina*, however, my sections appear to show that there are always two cells in any individual transverse section; and that, as Professor Minchin states, they are symmetrically disposed in pairs, but I can find no difference in structure in the upper and lower walls, and so doubt the existence of a structurally differentiated floor to the organ.

In *Stomoxys* there are also usually two cells in any individual transverse section, but they are placed not opposite each other, but alternately, so that only one of the oblong nuclei is ever visible in a single section, and opposite the middle of each the entire circumference of the tube is presumably formed by that cell alone. The number of giant cells would therefore be less than in *Glossina*; but, like Lieut. Tulloch, I have been quite unable to count them, and the heart is so

frequently damaged in serial sections of the entire insect that they throw no further light on the point beyond the fact that the nuclei are certainly opposite in *Glossina* and alternate in *Stomoxys*.

Seen in transverse section, the entire wall of the heart has an uniform structure but for the nuclei of its component giant cells. On close examination the protoplasm is seen to be broken up into masses of irregular prismatic section which form the cross view of the longitudinal striation, which is distinctly visible in longitudinal optical section. Plate i., fig. 9, represents a section of the anterior part of the heart of *Stomoxys* (Banded form ♀) in which, on the right side of the figure, one of the nuclei of that side is cut across, while that of the opposite side is divided beyond the nucleus, and so represented only by a slight projection. In pl. i., fig. 10, is shown a similar section of the back part of the heart of *Glossina*, in which the nuclei of the two component cells are divided at about a corresponding level. It is noteworthy that in this insect the cells project much more into the lumen of the tube than in *Stomoxys*, so that at their thickest part they appear connected with the body of the cell by a comparatively narrow pedicle. Fig. 11 is a semi-diagrammatic representation of a valve in *Glossina* as seen in optical section. It will be noticed that it differs somewhat from Prof. Minchin's account of the number of component smaller cells, in that three instead of two are represented as forming the valve, but the appearances presented by a structure seen in this way are notoriously deceptive, and I have no disposition to press the point. In *Stomoxys* I have as yet failed to obtain any satisfactory view of the valves. (*To be continued.*)

Correspondence.

To the Editors of the Journal of Tropical Medicine.

Dear Sirs,—The following case may be of some interest to younger members of the profession in the tropics. A blacksmith, S., aged 35, from Jerusalem, well-known as one of the strongest men in the place, consulted me three or four months since for abdominal pain. Nothing being much wrong with him I prescribed a purge with santoninum. Next day he came back much pleased with the relief he had experienced, but I could hardly understand why he was so pleased. However, next day his symptoms recurred, it being cold weather and no history of fever and chills being given, the idea of malaria never occurred to me.

Two days later I received an urgent message, and later an offer of double the usual fee if I would go at once to see him. He was doubled up with abdominal pain and had been very sick, but there was nothing in the abdomen to account for it. Finding he had a temperature of 103°, I took a slide of his blood, warning him that if the examination were negative he must go to hospital. The matter was cleared up, greatly to my surprise, by my finding numerous tertian parasites and gametes, and a few doses of quinine soon ended the attack; the spleen was not at all enlarged.

I am, &c.,

Ramallah, Jerusalem. J. Cropper.
June 13th, 1906.

To the Editors of the Journal of Tropical Medicine.

Sirs,—In the course of my work with films from yaws lesions and glands, I have been able to confirm some at least of the observations of Dr. McLennan (*British Medical Journal*, May 12th, 1906), connecting spir. pallida with cytorrhyctes luis.

The enclosed sketches were taken from a smear of serum of a cleaned frambœsia, stained in Giemsa solution. They show in the briefest way the almost certain identity of the organisms found in syphilis and yaws.

The study is a difficult one, especially for a medical officer "fed up" with work, and I have been handicapped by want of higher powers. The London School of Tropical Medicine lent me a $\frac{1}{15}$, but unfortunately they required it again before one had got well into the research.

I am now awaiting new lenses, and hope to be in a position to report progress later.

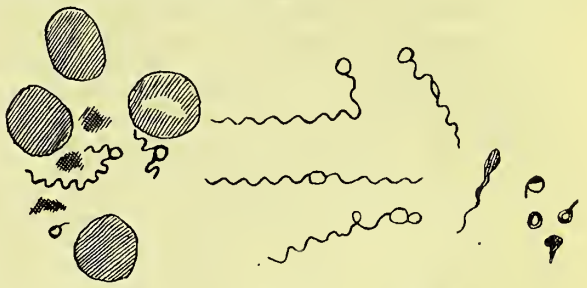


Fig. 1.
A group as actually seen.

Fig. 2.
Some forms occurring on same slide as fig. 1.

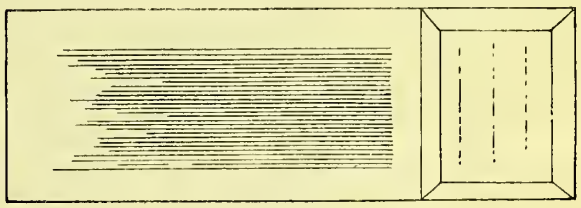
St. Vincent, B.W.I. C. W. Branch, M.B.
May 29th, 1906.

To the Editors of the Journal of Tropical Medicine.

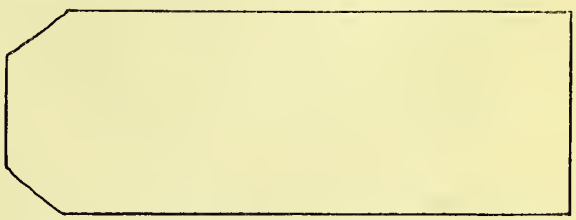
Dear Sirs,—I enclose a slide showing a method of preparing films of blood which I have found very useful in practice. It has the following advantages:—(1) Great simplicity. (2) The film can be made at any distance from the edge of the slide. (3) In an emergency the ear can be cut with the edge of the slide in the absence of knife or needle. An ordinary ground glass slide is clipped by scissors so that one end is narrowed to the desired width of the film, this varying according to the particular mechanical stage in use. The film is made in the ordinary way as described by Daniels, *i.e.*, with the end of the slide.

I am, &c.,

J. Cropper, M.D.



Film made by slide below.



Slide cut to desired width.

Diagnosis.

A poor patient comes to a doctor with pains in the abdomen and calves, and with jaundice. History shows sudden accession of fever without shivering and occurrence of similar cases of fever in the neighbourhood.

This fever is not malaria, because quinine in very big doses has no effect and patients do not shiver.

It is not plague, because almost all patients recover, there are no buboes, and the fever is less.

It is not rheumatism, because the pain is in muscles and tendons, and salicylate and alkalies have no effect on its course, and there is no swelling of joints.

It is not typhoid, because the duration is only seven days; the characteristic headache and slow pulse are wanting; there is no diarrhœa. Chlorine mixture seems to do harm in this disease.

The diagnosis is very simple if microscopic examination of the blood is made.

Treatment.

The fever runs its course and defies all methods of treatment. The less active medicinal treatment you give these people the better.

Opium in pill form, pushed to produce pin-point pupil, does some good.

Quinine in 5 gr. doses keeps a check on the peculiar "air hunger" respirations. Patients getting quinine have better pulse than those taking diaphoretics. The motions are less coloured under quinine. The relapse is more marked in patients who take quinine during the first attack.

All antiseptics seem to do harm in this fever.

Diaphoretic treatment is exhausting.

Cold water baths are very beneficial. Still, under cold baths the tongue does not improve as it does in typhoid; but the "air hunger" respirations diminish. The urine is improved by baths.

Food consisting of fresh fruits, especially oranges in abundance, fresh milk, fresh mutton broth with plenty of salt, and green vegetables is the proper diet. Alcohol seems to do harm in this fever; even the worst cases recover without a drop of it.

Nothing active should be done for the jaundice. Fomenting over the liver for pain does harm Vomiting is not amenable to any treatment.

To check the relapse residence must be changed at once. Fruits, port wine and plenty of common salt help to render the relapse less severe.

THE ANATOMY OF THE BITING FLIES OF THE GENERA *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Rtd.).

(*Continued from p.* 202.)

The heart lies almost free in the pericardial cavity; but is, nevertheless, firmly supported by muscular bands, the alar muscles described by Prof. Minchin, but these seem to me quite distinct from the strong antero posterior muscle which forms a part of the pericardial septum, and which, to judge from his plate lxv. is the structure so named by Lowne in his book on the blow-fly.

This latter structure is well represented in both *Stomoxys* and *Glossina*, and does not appear to me to have any direct connection with the heart at all, and is certainly not the same as the structures referred to under that name by Prof. Minchin, which seem to have a much better claim to be so called. The muscle of the septum is a very well marked structure, broad in front and narrow behind, and is somewhat fan-shaped. The more internal fibres soon join with those of the opposite side under the first two chambers of the heart, while most of the rest extend the whole length of the septum, of which they form a considerable portion of the substance. The septum, is, however a very complex structure. It is lined with a distinct layer of pavement, endothelium (*vide* pl. i., fig. 12) and there are said to be pores in it, whereby the pericardium communicates with the general body cavity. Besides this there appears to me to be a delicate but perfectly regular layer of unstriated transverse fibres. Its lateral attachments to the terga are embedded in thick masses of the fat-body. The fat-body appears to correspond to the "cellular" tissue of vertebrates, and forms the packing of the organs not only about the septum but in every other waste space of the body. It is composed of enormous cells which appear to be usually multi-nucleate, but as a rule, it is not easy to distinguish the limitations of the component cells. The protoplasm (as shewn in pl. i., fig. 13), is vacuolated, the spaces, in specimens that have not been treated with solvent reagents, being occupied with a reserve store of nutriment.

Besides the structures already enumerated as entering into the formation of the pericardial septum, there are two distinct sorts of cell which have been indifferently referred to by authors as "pericardial cells." One category of these (pl. i., fig. 14) are undoubtedly nothing more than young mononuclear fat cells, their protoplasms having exactly the same structure as the cells of the fat body. The others are very different and are multipolar cells (pl. i. fig. 15), the poles of which, according to Lowne, are muscular fibres. These form a network over especially the lateral parts of the septum, and look exactly like ganglion cells, though it is not suggested that they are of that nature. In studying the literature of the subject it is well, however, to remember that either of the above forms of cell may be referred to by a writer, as the obvious discrepancies between their descriptions are otherwise very confusing.

As far as the writer can see, Lowne's theory that the dorsal vessel is a hollow muscular fibre is a quite accurate description of the thoracic aorta, as it seems to consist of a single row of long cells, the sides of which curve upwards to meet in the middle line above. The protoplasm, with the nuclei of these cells, forms a continuous thread in the middle of the ventral wall of the tube, lying in contact with the dorsal wall of the gut, while the lateral prolongations, which form the walls of the vessel, are extremely thin and delicate. The lumen of the tube is triangular with the apex dorsal and the flat base ventral, so that it fills up the interstice between the gut below and the lowest pair of great longitudinal thoracic muscles, and is padded on either side by rows of fat-cells.

The generative organs.—These in all Diptera, and in both sexes, consist essentially of a Y-shaped tube, the branches of which lead up to a tract of generative epithelium. Into the point of meeting of the arms of the Y, there enters, in each sex, a pair of accessory glands, so that it would be, perhaps, more exact to describe the agygos reproductive duct as dividing into four follicles; as morphologically it seems probable that the reproductive and their accessory glands may be of the same value. In the male these glands are usually spoken of as the vesiculæ seminalis, but the term is an entire misnomer, as they secrete a milky coagulate fluid which mixes with the semen in the common sperm duct, but never contain spermatozoa. Structurally they closely resemble the parovaria, or corresponding accessory glands of the female. In *Stomoxys*, however, the usual arrangement is considerably modified, as the paragonia only exist as separate lateral organs for a fairly short distance as a pair of diverticula and then unite to form a single tube which, for the greater part of its length, seems quite without convolution, and runs beside the ejaculatory duct to its point of union with the common sperm duct, which immediately after divides into three—the lateral branches or vasa differentia (efferentia of Lowne) looping backwards to the testes, while the median extension widens to form a rudimentary ejaculatory sac, which, however, has neither the muscular loops nor the fan-shaped sclerite which make it such a prominent organ in the blow-fly.

The ejaculatory duct is so small in comparison with the paragonium which lies beside it that it is very likely to be overlooked in dissecting, and the paragonium mistaken for it, as the latter is 0·15 mm. in diameter, while the ejaculatory duct is but 0·05. The duct, vasa differentia and ejaculatory sac are of exactly similar structure, being formed of a structureless intima, lined with conical epithelial cells, the apices of which project into the lumen so as to impart to it a ragged outline. The paragonium is a peculiar structure, as the lumen of the tube is surrounded by a trabecular structure, the interspaces of which are filled with a granular material. The trabeculæ radiate towards the lumen, and so have a superficial resemblance to columnar epithelium, but though I have stained them in various ways, and the lining of the ejaculatory duct lying close by has the nuclei of its epithelia quite distinct, I have never seen any structure in the granular substance which could be regarded as a nucleus, while the trabeculæ are distinctly nucleated, especially at their internodes. On this account I prefer to consider the granular substance as intercellular. The testes are two small bodies enclosed in a sac formed of flat, deeply pigmented epithelium. In mature insects it is almost entirely filled with spermatozoa of enormous length, but in young insects trabeculæ of father cells project into the interior, and there may be but little ripe sperm.

The stages of the spermatogenesis seem to be quite normal and have been described *ad nauseam* by many writers. All these structures are imbedded in a dense mass of fat-body, and in front lie beside the rectum. A rather complicated system of muscles come into view in the hindmost sections of a series which actuate the rather complicated external genitalia. For most of their course the ejaculatory duct and paragonium run rather above the longitudinal axis of the insect, but as they approach the hypopygium bend sharply down to the venter.

The female generative organs are quite of the usual dipterous type, each insect producing in the course of a season an immense number of large oval eggs.

These eggs during their development lie more or less in rows of about four ova of various stages, and it is usual to speak of these rows as "ovarioles," but the cavity containing each ovule is just as separate from the more and less developed ovules below and above it respectively, as it is from those of similar development surrounding it, and the separation in both cases consists of an open stroma of muscular fibres without any definite intima or epithelial lining, so that fundamentally their structure is the same as that of the mammalian ovary with which human anatomists are familiar. The general arrangement and relations of the ovaries may be gathered from the following figure, which includes also a diagram of the ovipositor copied from Lieut. Tulloch's paper.

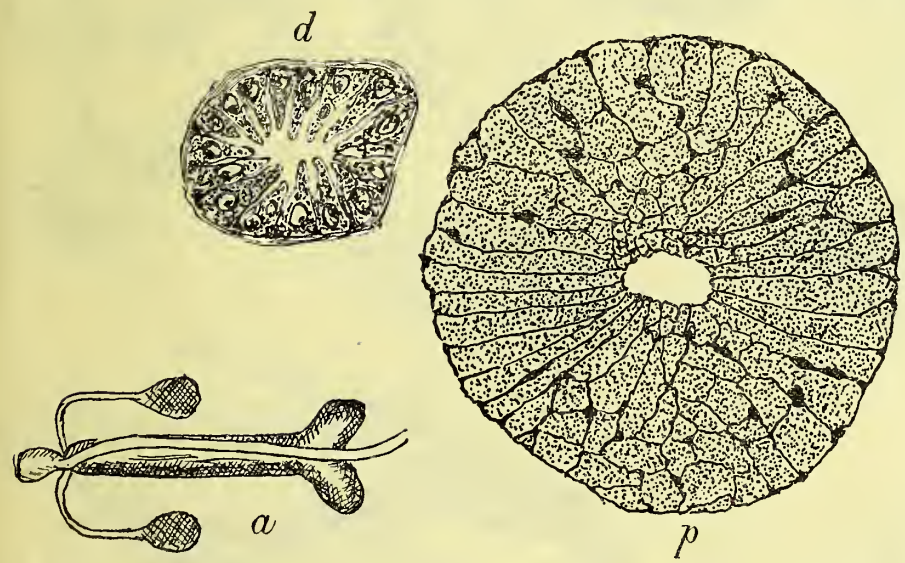


FIG. 33.—*a*, diagrammatic representation of male internal generative organs; *p*, transverse section, paragonium; and, *d*, transverse section, ductus ejaculatorius, × 400 diams.

The lateral oviducts, too, cannot be said to expand into a funnel-shaped receptacle receiving the ovarioles, as it seems rather a portion of the general body cavity into which the branches open, which latter receive the

ovules after the dehiscence of the muscular alveoli in which they lie, and to which they are guided by a continuity of the muscular structure of the ovary with that of the wall of the oviduct.

The smallest germ cells are multinucleate masses surrounded by a capsule of small cells. The next larger form (*b*) has two nuclei, and spring from a small celled mass on one side, while on the other the capsule is lined with large columnar epithelium, from which is developed the chorion which forms the shell of the full grown ovule (*c*). In the less mature eggs the chorion is still recognisable as a lining of flat cells (*d*) within the shell, but in those ready to pass into the oviduct it is difficult to distinguish this membrane. In ovaries in a certain stage of development before the chorion has changed into egg-shell, it is easy to mistake it for an epithelial lining of the ovariole. The eggs (*c*) are elongated ovoids having at their upper end an infolding of shell and chorion which leads to a minute canal, the microphyle, passing to the interior of the ovum to give passage to the sperm cells of the male. The stroma separating the ovarioles consists of elongated spindle cells containing each a row of nuclei. In (*e*) these muscle cells are represented in the inter spaces between three contiguous ovules. Under a high power it can be made out that the egg-shell is fibrillated, or striated vertically to its surface. Towards the end of the common oviduct there opens into it the two accessory glands (parovaria), and the ducts of the three spernothecæ.

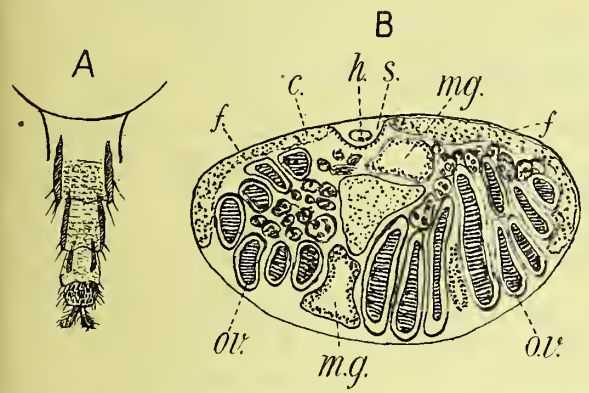


FIG. 34.—A, diagram of ovipositor, after Tulloch; B, transverse section of abdomen of gravid female; *c*, crop; *f*, fat-body; *h*, heart; *mg*, mid-gut, × 28; *ov*, ovules; *s*, pericardial septum, × 20.

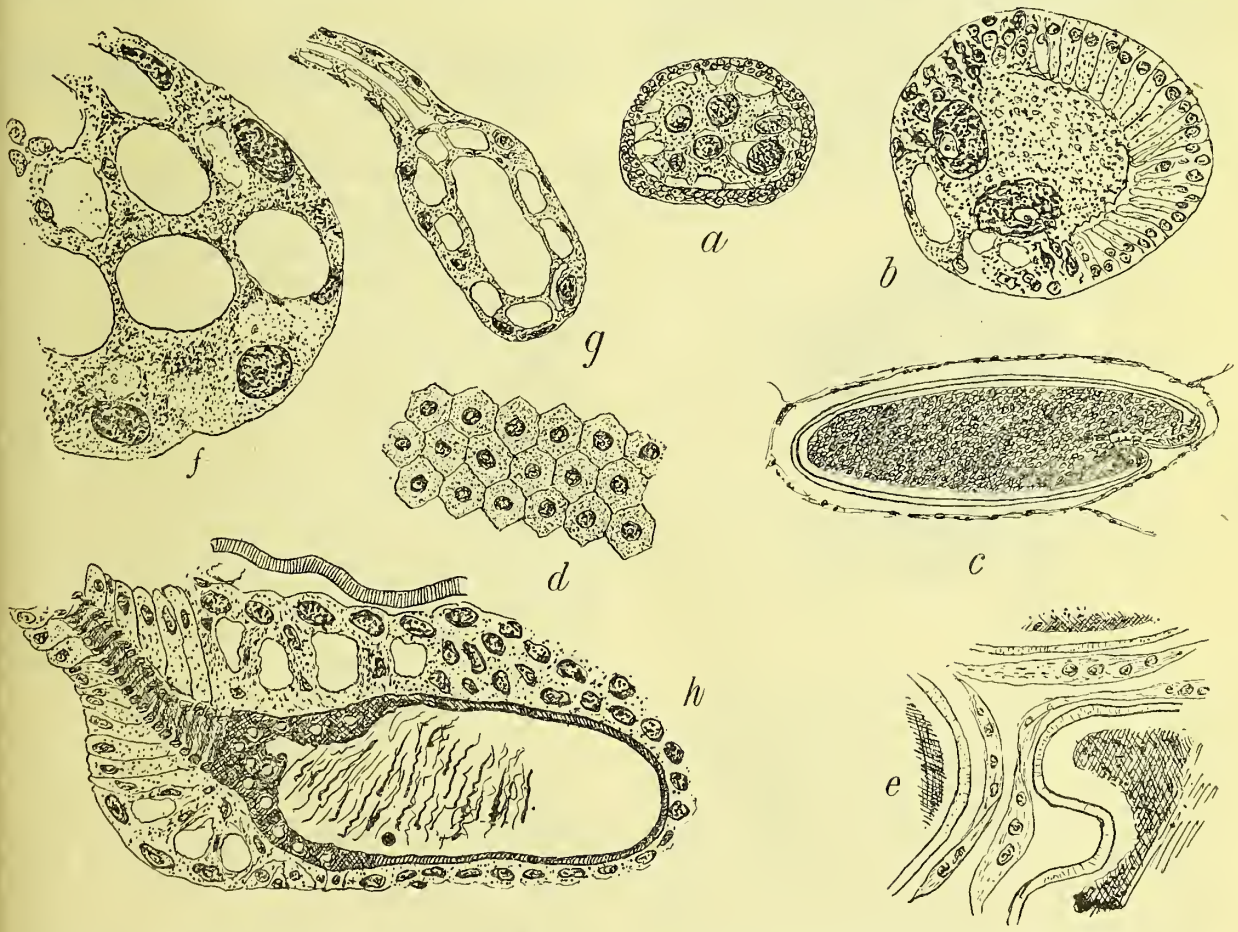


PLATE II.—*a*, Young ovariole, × 270; *b*, ovariole further developed, × 270; *c*, fully developed egg in its alveolus, × 50; *d*, portion of chorion or lining membrane of egg shell, × 270; *e*, muscular stroma separating three ovarioles, × 270; *f*, portion of parovarium, × 540; *g*, the same and its duct, × 270; *h*, section of one of the vesiculæ seminalis, × 540.

(*To be continued.*)

Bassianum Laudum. "De originis et causa pestis Patavinæ."
Venetiis An., 1555, Id. "Cura della Peste," Ven., 1557.
Th. Jordanus. "Pestis Phœnomena," &c., Francofurti, Wechelus, 1576.
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Hier. Mercurialis. "De peste præsertim de Veneya et Patavina," Basel, 1577.
Prosper Borgantius. "De Peste," Ven., 1565.
Victor de Bongentibus. "Decem Problemata de Peste," Ven., 1556.
Georgius Agricola. "De Peste in 1630," Mediolanum, 1641.
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[25] O'Meara. "Conquête de la Palestine," 1799. Editée par Napoléon (without date).
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[28] J. Cantlie. *Lancet*, 1897, pp. 4-85; *idem*, 1897, p. 349, "Plague: How to Recognise, Prevent and Treat Plague," London, 1900.
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[30] G. Gaglio. *Archivio per le scienze mediche*, vol. xxi., p. 341; A. Baldoni, *Boll. della R. Acc. Medica di Roma*, Ann. xxxi., Fasc. 1.
[31] "Report of the Indian Plague Commission," vol. v., p. 444.
[32] Scheube. "Die Krankeiten der warmen Länder," Leipzig, 1900.
[33] P. Manson. "Tropical Diseases," London: Cassell and Company, Ltd.

THE ANATOMY OF THE BITING FLIES OF THE GENERA *STOMOXYS* AND *GLOSSINA*.

By Lieut.-Colonel G. M. Giles, I.M.S. (Rtd.).

(*Continued from p.* 219.)

The parovaria (fig. 9) are two long, somewhat convoluted tubes, the larger distal ends of which are attached to the branches of the oviduct near to the point, where they loose themselves in the stroma of the ovaries. They then pass backwards into the ovipositor, and then turn forwards again to their termination in the common oviduct. They have the same trabecular structure as the paragonia, but the trabeculæ and the nuclei of their internodes are much larger, and a comparison of fig. 9, Plate I., with fig. *b*, Plate II., shows that they also present resemblances in structure to that of the younger ovarioles. They appear to secrete a coagulable fluid similar to that of the paragonia. The remaining accessory structures are the spermothecæ or receptaculæ seminis, of which there are three, each of which (Plate II., fig. *b*.) consists of a dense chitinous sac supported in a cellular mass like an acorn in its cup.

The chitinous membrane is fenestrated, as will be seen in fig. 2, and the ducts are supported by a spiral fibre somewhat like that of a trachea, but much coarser.

Only one coitus takes place between the sexes, and in these sacs sufficient semen is stored on that occasion to last the life of the female.

The ovipositor is quite of the usual type. Lieut. Tulloch describes it as follows:—

"The ovipositor consists of three cylindrical segments of thin chitin, which usually lie telescoped inside the abdomen. There is also a single external flap of dark chitin, which lies folded upon the ventral surface of the fly. When the ovipositor is extruded, by squeezing the abdomen, the receptacula and uterus are pulled down with it and can be seen through the transparent walls. The upper segment has three longitudinal rods of chitin, two dorsal and one ventral. The next is similar, but the last has the two dorsal plates only. The external flap, which is probably the ventral rib of the last segment, is roughly quadrilateral, and has no divergent prong-like processes arising from its free hinder border."

Within the ovipositor is a complicated system of circular and longitudinal striated muscles, which perform the actions of protrusion and retraction.

The male organs of *Glossina*, as far as their histology is concerned, present no notable differences from those of *Stomoxys*, but according to Prof. Minchin, the paragonia are more of the usual type, being distinct from each other throughout. Those of the female, on the other hand, depart entirely from the usual fly-type, being modified to meet the peculiar plan of reproduction of these insects which give birth not to a multitude of eggs but to a very limited number of larvæ. Owing to this, the common oviduct or uterus is of great size, and to expel the large full-grown larvæ the ovipositor is provided with muscles, which, although on the same plan as those of *Stomoxys*, are so enormously developed that a section of this part of the body on a casual glance looks much like one of the thorax of an ordinary fly. Prof. Minchin's description runs as follows:—

"The female genital organs differ considerably in appearance, according as they are in the gravid or non-gravid condition. In the course of my dissections I have only found one female in the latter state. In the later periods of gestation the condition of the female is obvious externally, but females which do not appear to be gravid are found on dissection to have a small larva in the uterus.

"The female organs (fig. 35) consist, like those of the male, of paired and unpaired portions. The former comprise the ovaries, the receptacula seminis and their ducts, and the

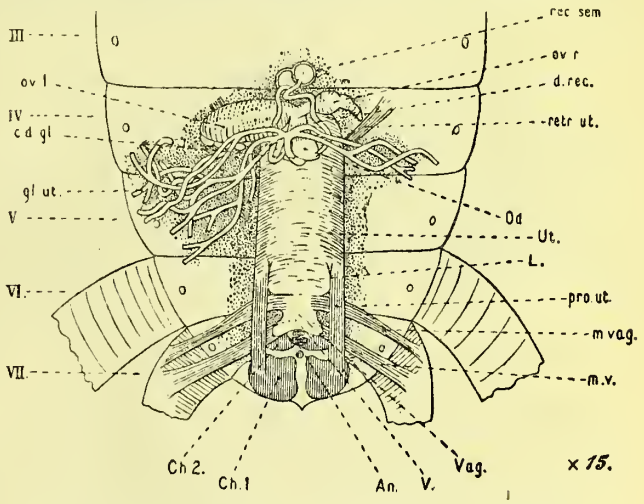

Fig. 35.—The hinder segments of the abdomen with the female genital organs of Glossina *in situ*, dorsal view. *rec. sem.*, receptacula seminis; *ov. r.*, *ov. l.*, right and left ovarioles; *d. rec.*, duct of the right receptaculum seminis; *gl. ut.*, uterine glands (the greater number of these have been removed); *c. d. gl.*, their common duct; *retr. ut.*, retractor muscle of the uterus; *Od.*, oviduct; *Ut.*, uterus; *L.*, hinder extremity of the larva, causing a bulge in the uterus; *pro. ut.*, protractor uteri, attached to the chitinous plate (*Ch.* 1); *m. vag.*, muscle (dilator vaginæ?) passing from the vagina to the tergum of the seventh abdominal segment; *m. v.*, muscle passing from the paired chitinous plate (*Ch.* 2) on each side of the vulva to the seventh tergum; *Vag.*, vagina; *V.*, vulva, the anterior margin of which is shown by a dotted line; *An.*, anus; *Ch.* 1, *Ch.* 2, paired chitinous plates. (After Tulloch.)

uterine glands; the latter are the oviduct, uterus, and vagina. The female system of organs is considerably modified from the condition usually found in insects, in relation to the fly's peculiar method of reproduction.

"The ovaries are reduced to a single pair of ovarian tubes or ovarioles, one on each side of the body (figs. 35 and 36, *ov. r.*, *ov. l.*). Each ovariole shows only a small number of egg-chambers, not more than four or five. The lowest chamber is very much larger than any of the others, and contains a large ovum. When this ovum is comparatively small, the other egg-chambers are in a line with it (fig. 6,

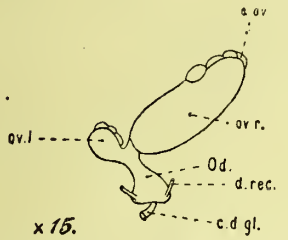

FIG. 36.—The ovarioles and oviduct of a non-gravid female Glossina. *a. ov.*, apex of right ovariole; other letters as in the preceding figure. The very large ovum in the right ovariole has pushed the oviduct over towards the left side of the body.

ov. r.), but as the ovum grows larger it grows past the other egg-chambers, so that they appear attached to the side of the ovum (fig. 35, *ov. l.*, fig. 36, *ov. l.*, *ov. r.*).

"The two ovarioles are always asymmetrical, owing to the fact that the ova in the lowest egg-chambers reach full growth on each side alternately, so that if there is a large ovum on the left, there will be a smaller one on the right, and *vice versâ*. The largest ovum I have seen was from a non-gravid female (fig. 36, *ov. r.*), and was probably nearly, if not quite, full-sized.

"The two ovarioles open into the short, broad oviduct (figs. 35 and 36, *od.*), which widens out at its lower end to open into the uterus slightly behind the proximal end of the latter.

"At its distal-expanded end the oviduct receives right and left the two ducts (*d. rec.*) of the receptacula seminis. The latter (*rec. sem.*) are small spherical bodies of a bright orange-yellow colour, surrounded by a whitish, transparent envelope. Examination of the receptacula stained and mounted in Canada balsam shows that the clear envelope is an epithelium of large cells, surrounding a thick chitinous membrane which gives these organs their peculiar colour, and which is too opaque for the contents to be seen except in sections, by which method the receptacula are seen to be filled with spermatozoa. The two receptacula are firmly attached to one another. From each comes off the slender white duct, slightly convoluted. The ducts are perfectly distinct from one another, and open, as described above, into the lower end of the oviduct.

"Immediately below the opening of the oviduct into the uterus, a small tube debouches into the latter by a median dorsal aperture. This is the common duct of the uterine glands (figs. 35 and 36, *c. d. gl.*). After a short course it branches right and left into tubes, which branch again repeatedly, forming a great number of glandular tubes, which differ markedly in the gravid and non-gravid condition. In the latter state the gland-tubes are relatively few and very slender. In the gravid condition, on the other hand, the tubes are very numerous, forming a tightly packed mass filling up the posterior end of the abdomen, and requiring to be pulled away to show the other parts of the generative system; further, the individual tubes are much thicker, and when stained and mounted, they take up the stain very deeply and appear very opaque. There can be no doubt that these glands serve for the nourishment of the larva in the uterus.

"The uterus (*Ut.*) is a large thimble-shaped organ attached to the body-wall by a number of muscles. Two retractors (*retra. ut.*) run forwards from the proximal end. There are two pairs of protractors, one dorsal, the other ventral; the former (*pro. ut.*) start from the sides of the uterus and pass backwards to a pair of chitinous plates (*Ch.* 1) at the posterior end of the body. The wall of the uterus is beset by a very large number of small tracheal tubes (not shown in the figure), and is thick in the non-gravid condition, but becomes thinner when stretched by the growth of the contained larva. In all gravid uteri that I have seen, the two papillæ at the hinder end of the larva cause a bulge in the lower end of the uterus (fig. 35, *L.*). When the larva reaches a certain size, the rings of its segments become plainly visible through the wall of the uterus; they could not be seen in the uterus drawn in fig. 35; but in another, slightly larger, they could be seen distinctly."

The writer is under the impression that there are three and not two receptacula seminis, but the opinion is derived from series of sections and not from dissection.

Only four or five larvæ are produced by each female in a season, so that the insect is much less prolific than even certain mammals, and it can scarcely be doubted that this circumstance offers the best hope of their destruction, as it is obvious that under such conditions the destruction of an adult is a much more serious blow to the chances of multiplication of the race than that of many score of the ordinary oviparous flies. It seems, then, that much might be hoped for from the systematic destruction of the adult flies, and in view of the terrible ravages of sleeping sickness, it cannot be denied that the object is one on which considerable expenditure of money and energy would be more than justifiable.

"Berliner Klinische Wochenschrift," vol. xliii., No. 7.

AFRICAN RELAPSING FEVER.

Koch finds that although quinine is useless in relapsing fever, the trypan-red is of some value. Seeing that immunity is conferred by one attack, Koch is led to hope that some form of serum treatment will be found efficacious. Whilst travelling in an endemic centre of the disease, Koch found that by pitching tents on fresh ground, apart from the old-standing shelters, relapsing fever could be avoided, as the tick only prevails in the dry, long-built shelters on the caravan route.

"Annales de l'Institut Pasteur," Paris, vol. xx., No. 3.

THE FRENCH REPORT ON YELLOW FEVER.

Marchoux, E., and Simond, P. L., in the final instalment of the Report on Yellow Fever by the French Commission to Brazil, go fully into the part played by infant infection in maintaining the endemicity of yellow fever. An outbreak of yellow fever leaves the community almost entirely immune to the disease. Those who escape at the time of the epidemic may subsequently develop the disease in the form of sporadic cases, but were it not for new-born infants the non-immunes would soon be exhausted. Owing to the mildness of the disease in children the affection may escape notice, and because the adults are not attacked the disease is supposed to have died out, whereas in reality it is being continued amongst the infants. This possibility serves to explain how non-immune aliens contract the disease on arrival in the yellow fever zone. The apparent immunity of the negroes to yellow fever is no doubt explainable on the assumption that they had a mild type of the disease in infancy and thereby became protected against subsequent seizure.